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INSTITUTE ON PUBLIC HEALTH, 1947

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PUBLISHER'S NOTE

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Foreword

THIS volume contains the quintessence of the papers and discussions at the Institute on Public Health which was held at the New York Academy of Medicine on April 1, 2, and 3, 1947, as a part of the Centennial Celebration of the Academy.

The Institute dealt with certain basic aspects of public health; these embraced genetics, maternal health and nutrition; animal and insect reservoirs of disease; climate, geography, and disease; realities in preventive psychiatry; trends in the development of state and local health services in the United States; professional and lay education; and the public health implications of the Hill-Burton Act. Men and women who have made significant contributions to the various phases of ecology, social biology, and public health administration participated in the discussions. Altogether forty-seven people were on the program, and, in addition, a number of persons in the audience contributed ideas as well as information.

The presentations were of such high quality that it was thought desirable to make a permanent record of them, not, however, as transactions, but in a form that would give the gist of the original papers and the comments in a comparatively small volume without reference to the individual contributors or discussants. Three papers were left practically in their original form—the presentations by Franklin Bobbitt, Ph.D., Haven Emerson, M.D., and C.-E. A. Winslow, Dr.P.H. All the other chapters are distillates of the discussions which took place at the sessions.

With one exception, no outside material has been brought within the scope of the chapters. In other words, no effort was made to make this volume an exhaustive study of each of the problems with which it is concerned, and no bibliography has been attempted. The only exception is the chapter on "Trends in State and Local Health Service in the United States" to which, for the sake of chronological accuracy and in order to trace developments which have taken place since the conference, supplementary material was added in the editing.

The names of those who participated in the discussions are given at the opening of each chapter.

The credit for planning the Institute goes to the Committee on Arrangements, which consisted of Dr. Harry S. Mustard as Chairman, Dr. Reginald M. Atwater, Dr. Haven Emerson, Dr. Norman Jolliffe, Dr. George K. Strode, and the writer as Secretary. Special recognition for effective help in preparing this material is hereby accorded to Miss Elizabeth V. Cunningham.

E. H. L. Corwin, Ph.D.
Executive Secretary
Committee on Public Health Relations
New York Academy of Medicine

June 1949

Introduction

As is said in the Preface, this volume records contributions of the Institute on Public Health, held as part of the Centennial Celebration of the New York Academy of Medicine. It is meet and proper that a volume of this sort should be a product of that celebration, for improvement of the public health has long been a primary interest of the Academy. Through its Committee on Public Health Relations and in other ways as well, the Academy has established an honored record in this field.

The material in this volume is, of itself, worth while and interesting. Particular attention is directed to the fact that the proceedings of the Institute are not presented here in their original form. The chapters of the volume are, in most instances, the composite of formal presentations, prearranged discussion, and extemporaneous comment. By hard work and skillful editing completeness has been assured, repetition eliminated, and reading time brought within practical limits.

In view of these considerations, this volume needs no extensive apologia. It may be regarded, however, as a point of departure for the next century's progress in public health and as a milestone from which to consider both prospect and retrospect. Retrospect may be disposed of quickly, for it is now a matter of history, recorded for those who may wish to read. Prospect, however, provides a tempting opportunity to send a message to those who will be concerned with the public health a hundred years hence.

We set forth in the following pages the program of the Institute from which this volume has sprung. Most of the accomplishments and characteristics of those whose names are listed as participants will have been lost in the mists of time that accumulate in a century, and many of the problems will have been solved. But the problems and preoccupations and speculations of those interested in public health in 1947 may be well and truly seen in this program and this published volume.

GENETICS AND THE PUBLIC HEALTH

Chairman FRANZ SCHRADER, Ph.D., *Professor of Zoology, Columbia University*

Leaders

HERMANN J. MULLER, Ph.D., *Professor of Zoology, Indiana University*

LAURENCE H. SNYDER, Sc.D., *Chairman, Department of Zoology and Entomology, Ohio State University College of Medicine*

Discussants

M. DEMEREC, Ph.D., *Director, Department of Genetics, Carnegie Institution*

TH. DOBZHANSKY, Sc.D., *Professor of Zoology, Columbia University*

DOUGLAS P. MURPHY, M.D., *Director, Office of Health Survey, Hospital of the University of Pennsylvania*

MATERNAL HEALTH: A PROBLEM IN PREVENTIVE MEDICINE

Chairman HOWARD C. TAYLOR, M.D., *Professor of Obstetrics and Gynecology, College of Physicians and Surgeons, Columbia University*

The New York Academy of Medicine's Study of Fifteen Years Ago
GEORGE BAEHR, M.D., *President, The New York Academy of Medicine*

Maternal Nutrition: Results of Recent Studies

Leaders

JOHN H. EBBS, M.D., *University of Toronto Faculty of Medicine*

WINSLOW T. TOMPKINS, M.D., *Division of Obstetrics and Gynecology, Pennsylvania Hospital*

JOSEF WARKANY, M.D., *Children's Hospital Research Foundation, Cincinnati*

Discussants

CARL T. JAVERT, M.D., *Assistant Professor of Obstetrics and Gynecology, Cornell University Medical College*
OLIVER H. LOWRY, M.D., *The Public Health Research Institute of the City of New York, Inc.*
HAROLD C. STUART, M.D., *Associate Professor of Child Health, Harvard University School of Public Health*

ANIMAL AND INSECT RESERVOIRS OF DISEASE

Chairman WILSON G. SMILLIE, M.D., *Professor of Public Health and Preventive Medicine, Cornell University Medical College*

Leaders

WILLARD H. WRIGHT, D.V.M., *Chief, Division of Zoology, United States Public Health Service*
FRED L. SOPER, M.D., *Director, Pan American Sanitary Bureau*

Discussants

HENRY E. MELENEY, M.D., *Professor of Preventive Medicine, New York University College of Medicine*
JOHN C. SNYDER, M.D., *Professor of Bacteriology, Harvard University School of Public Health*

CLIMATE, GEOGRAPHY, AND DISEASE

Chairman WILBUR A. SAWYER, M.D., *Director of Health, U.N.R.R.A.*

Leaders

RICHARD U. LIGHT, M.D., *President, American Geographical Society*
CLARENCE A. MILLS, M.D., *Professor of Experimental Medicine, University of Cincinnati College of Medicine*

Discussants

GAYLORD W. ANDERSON, M.D., *Mayo Professor and Director of the School of Public Health, University of Minnesota Medical School*
JAMES A. DOULL, M.D., *Chief, Office of International Health Relations, United States Public Health Service*
LUDWIG W. EICHNA, M.D., *Assistant Professor of Medicine, New York University College of Medicine*

REALITIES IN PREVENTIVE PSYCHIATRY

Chairman DANIEL BLAIN, M.D., *Chief of Neuropsychiatry, Veterans Administration, Washington, D. C.*

Leaders

The Child, MARIAN C. PUTNAM, M.D., *Co-Director, The James Jackson Putnam Children's Center, Roxbury, Mass.*

The Adolescent, MILTON J. E. SENN, M.D., *Associate Professor of Pediatrics in Psychiatry, Cornell University Medical College*

The Adult, M. RALPH KAUFMAN, M.D., *Chief Psychiatrist, Mt. Sinai Hospital, New York*

Discussants

MOLLY HARROWER, Ph.D., *Clinical Psychologist, New York*

MARION E. KENWORTHY, M.D., *Professor of Psychiatry, New York School of Social Work, Columbia University*

CARL A. BINGER, M.D., *Assistant Professor of Clinical Psychiatry, Cornell University Medical College*

TRENDS IN DEVELOPMENT OF STATE AND LOCAL HEALTH SERVICE IN THE UNITED STATES

Chairman EDWARD S. GODFREY, JR., M.D., *Commissioner, New York State Department of Health*

Leaders

CHARLES L. WILLIAMS, M.D., *Assistant Surgeon General, United States Public Health Service*

JAMES E. PERKINS, M.D., *Deputy Commissioner, New York State Department of Health*

Discussants

MARTHA M. ELIOT, M.D., *Associate Chief, Children's Bureau, Federal Security Agency*

SAMUEL FRANT, M.D., *Deputy Commissioner, New York City Department of Health*

PROFESSIONAL AND LAY EDUCATION IN SUPPORT OF THE PUBLIC HEALTH

Chairman REGINALD M. ATWATER, M.D., *Executive Secretary, American Public Health Association*

Leaders

Franklin Bobbitt, Ph.D., *Professor of Education, Emeritus, University of Chicago*

C.-E. A. Winslow, Dr.P.H., *Professor of Public Health, Emeritus, Yale University School of Medicine*

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Mayhew Derryberry, Ph.D., *Consultant in Health Education, The American Red Cross*

Charles E. Lyght, M.D., *Director of Health Education, National Tuberculosis Association*

Herman G. Weiskotten, M.D., *Dean, Syracuse University College of Medicine*

GOVERNMENT AND PUBLIC HEALTH

Chairman James Alexander Miller, M.D.

The Hospital Survey and Construction Act and a Nation-wide Health Program, *The Hermann M. Biggs Memorial Lecture*

Haven Emerson, M.D., *Professor of Public Health Practice, Emeritus, Columbia University*

Government and Medicine

Hon. H. Alexander Smith, *United States Senator from New Jersey*

In examining this program, it should be noted that we had a fear that artificially imposed and accelerated genetic changes might work to the detriment of man; but it will be seen also that there was a faint and vague hope that, by some means less subject to defeat than are the variables of eugenics, an improvement might be made in the human species. The readers of 2047 will note, too, perhaps with scholarly amusement, that this centennial committee was concerned with the nutritional aspects of maternal hygiene. Doubtless these problems of maternity and others not even visualized today will have been solved in the coming century, so that this feature will be of academic interest only.

In 1947 we still paid tribute to ecology and remained concerned with animal and insect reservoirs of disease and with climate and geography. And lest you fail to detect the significance of it, we call to your attention the fact that we made an earnest effort to discover the realities of preventive psychiatry. We have recognized this subject as important, we have talked about it a good deal, but from a practical standpoint we have made little progress.

Finally, we ask you who are the public health workers of 2047 to study the chapter that sets forth the trends in development of state and local health services in the United States as of 1947. If you note that on the program the subject was limited to state and local health service you may, with your perspective of 2047, know that federal developments proved to be the determining factor in all areas of government.

We trust that you will have solved all these problems and others that will have arisen between now and then. In any event, this volume presents a good, though limited, cross section of public health thought, speculations, and aspirations in that year of grace 1947.

HARRY S. MUSTARD, M.D., *Chairman*
Committee on Arrangements
Institute on Public Health

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CHAPTER I

This chapter has been prepared from a major paper presented by Hermann J. Muller, Ph.D., Professor of Zoology, Indiana University, with the addition of discussions by Laurence H. Snyder, Sc.D., formerly Chairman, Department of Zoology and Entomology, Ohio State University College of Medicine, and now Dean, Graduate College of the University of Oklahoma School of Medicine; Milislav Demerec, Ph.D., Director, Department of Genetics, Carnegie Institution; Th. Dobzhansky, Sc.D., Professor of Zoology, Columbia University; Douglas P. Murphy, M.D., Director, Office of Health Survey, University of Pennsylvania, Philadelphia; Philip Levine, M.D., Director of the Biologics Division, Ortho Research Foundation, Raritan, N.J.; and Franz Schrader, Ph.D., Professor of Zoology, Columbia University.

Genetics and the Public Health

THE field of public health has always been noted for its ability to put to practical use the basic discoveries of the various sciences which have something to contribute to public welfare. With medicine as a core, public health has enlisted the aid of biochemistry and biophysics, bacteriology, sanitary engineering, statistics, entomology, veterinary medicine, and sociology. During recent years a new discipline has been added to this roster, one whose potential importance is becoming more and more apparent. This is the science of genetics.

Contribution of Genetics to an Increase in the Food Supply. Maintenance of an adequate food supply is one of the outstanding problems of our civilization and one which has a direct bearing on the health of a considerable proportion of the human race. Even when conditions are normal, undernourishment with high death rates may be prevalent among a large section of the human population, and after upheavals like the recent war the scourge of near-hunger may involve a majority of the race.

Genetics has made a significant contribution toward increasing the production of food resources, particularly the important group of food plants, the cereals. Hybrid corn affords a striking illustration of this advance. A discovery made by George H. Shull in the course of theoretical research was directly applied in practical breeding with the result that the yield of corn was increased by about 25 per cent. When it is recalled that today more than 99 per cent of the corn grown in the corn belt is hybrid corn, it is evident what this application of a discovery in the field of genetics has meant in terms of food for livestock and, eventually, the meat supply. And this has been accomplished without the use of additional land or additional labor for cultivating the land.

Contribution of Genetics to Antibiotic Therapy. A similar successful application of genetic knowledge for the benefit of human health occurred during the recent war. In 1944 the War Production Board asked a group of geneticists to investigate the possibility of increasing the yield of penicillin which was then still extremely limited. An intensive research program was organized in which five laboratories cooperated. The general information then available justified the assumption that genetic factors were responsible for differences in the yield of various strains of *Penicillium,* and it was therefore reasoned that if the genes could be changed, it might be possible to increase the yield. Because of the discovery by Hermann J. Muller of Indiana University that radiation will bring about mutations in genes, the *Penicillium* was irradiated and an extensive search was made for mutants giving a high yield of penicillin. The results were gratifying. In less than one year a strain was isolated in which the amount of penicillin obtained was increased from between 100 and 150 units per cubic centimeter of *Penicillium* to between 300 and 350 units; subsequent improvements made possible a production of from 500 to 700 units per cubic centimeter. Thus, by the application of genetic methods, a five- to sevenfold increase in production was brought about without any additional equipment or labor.

Geneticists have made another contribution to medicine by the analysis of the origin of bacterial fastness to antibiotics and drugs. The study of bacteria by genetic methods indicates that strains resistant to penicillin, streptomycin, and sulfonamide drugs may originate through mutations, and that the nature of the origin is not influenced by the presence of the antibiotic. The antibiotic eliminates susceptible bacteria, thus providing resistant individuals which have originated through a change in genetic constitution with an opportunity to survive and multiply. An understanding of the mechanism by which resistant strains originate has made it easier to plan the clinical use of antibiotics in such a way as to minimize the chances of multiplication of resistant strains. Theoretically it is entirely feasible to arrange conditions in which resistant strains would, for all practical purposes, have no chance to develop.

Application of Genetic Principles to the Study of Human Mutations. The public health implications of genetics are not confined to external elements which may affect man's well-being; the phenomenon of mutation in man himself also has a direct relationship to health problems. This is not always recognized because to many the word mutation conveys pictures of rare and bizarre monstrosities such as the armless-legless man, the microcephalic idiot, the lion-faced boy, and other circus wonders. Although in most cases such curiosities have arisen as a result of mutation, this is an entirely one-sided and far too narrow view of the phenomenon. Even though the mutant does deviate in some way from the preceding and more usual type, nevertheless mutated hereditary determiners, or genes, are so widespread in their incidence that everyone undoubtedly harbors several or many of them which he has received from more or less distant ancestors. For the most part these mutations are in a latent condition, but a few attain some degree of expression in the individual.

Characteristics of Mutations. It is true that a mutant may be called abnormal in a particular respect if the term abnormal is defined as meaning merely the less usual in that respect considered alone. Nevertheless, the phenomenon of mutation itself —that is, the occurrence of changes which are reproduced in subsequent generations—is, in a sense, the most normal thing about all living matter, being the property that basically distinguishes living from nonliving matter and that has allowed living matter to develop in its evolution all the peculiarities of its marvelous organization. For according to the modern geneticist's view of evolution, the entire body structures of man and every other animal and plant with all their complicated physiological and biochemical processes have been built up through hundreds of millions of years by means of a long succession of mutations, probably millions in all. The thousands of different kinds of genes which we now contain and which we call normal genes cooperate biochemically in most complicated ways in the formation of every body organ and characteristic. Since any one of these many genes can mutate again and can doubtless mutate in various different ways and in various different degrees, it would not be possible by a few examples even to scratch the surface of the mutational possibilities in man or any other organism. For anything that can be done by the organism in its development or in its later functioning can be undone by means of mutation or can be changed in any one of numerous different ways. In a sense, then, a mutation can do anything that life itself can do.

Most frequent among mutational changes are the little ones. These are often so imperceptible in their effects that they are overlooked and it would take the most refined methods to reveal them. Nevertheless these have great importance, all told. It would be futile and misleading, however, to present examples of them here, inasmuch as they are of kinds without number.

The whole intricate human organization, then, is built up of a fabric of thousands of different kinds of genes, each of which was a mutation in its day but which has happened to survive and so is called normal by this time. Nevertheless, it is only the rare mutation which thus succeeds in surviving. For mutations are the effects of accidents to the genes, and accidents in this realm as in any other are not generally beneficial. Most of the mutations fail and die out without ever being seen; they are the mute, inglorious mutations.

To acquire a real understanding of mutations, it will not do simply to make a search through the population for abnormal forms, because most of the hereditary abnormal types that would be found have actually been in the population for a long time, having arisen many generations ago. Thus they have already been subjected to much picking over and weeding out.

only, unlike the remnants in a department store, it is, on the whole, the better samples that are left. To get a view of what most mutations are like and in what relative frequencies they occur requires the examination of a group of newly arisen mutants that have not yet had time to be subjected to natural selection. This requires the use of special genetic techniques which are not yet applicable to man.

Fresh mutations can most easily be obtained by the irradiation of an organism which is easily bred. There is evidence, however, that substantially similar results are occurring naturally in most animals and plants and that man can be no exception. Because they are easily bred, fruit flies of the kind called *Drosophila melanogaster* are the favorite research subjects of geneticists. When fruit flies are given a heavy irradiation, about 4,500 *r* units (roentgens) and are bred with untreated flies or with each other, not one in a hundred of the offspring will show any conspicuous visible abnormality, although a search through thousands will eventually reveal a few abnormal types. In order for most of the mutants to come to light, three generations of the offspring must be put through special genetic tests. Even then, so small or so obscure is the visible expression of the mutation that its effects are seldom actually seen.

The presence of the mutations may be detected indirectly by the absence or the relatively infrequent appearance of certain expected types of individuals in certain families. These individuals carry given treated chromosomes, all derived from the same treated germ cell ancestral to that family; they carry no homologous, nontreated chromosome nor even a homologous, treated chromosome derived from a different germ cell, for a chromosome of different origin would tend to normalize the effect. In such tests crosses must originally have been made between individuals of different stocks. The chromosomes of these individuals must have been conspicuously differentiated by having contained in the beginning certain known genes of visibly contrasting effect, such as, in flies, white versus red eyes or short versus long wings. The corresponding chromosomes of the individuals crossed should also preferably differ in the arrangement of their genes, so that the oppositely marked chromosomes cannot interchange parts, or "cross over," with one another. Thus the visible character serves as a biological marker for the whole of a given treated chromosome. Then there must be a special type of breeding, usually a kind of strict inbreeding following the first cross with no intercrossing between the descendants of different germ cells of the original treated individuals. This method allows the tag or marker to show up in a whole group of second or third generation descendants in a certain expected ratio such as the Mendelian 1:3.

If in such a system of breeding a fresh mutation occurs in a given treated germ cell in which one of the chromosomes also carries a marker gene, those descendant individuals in the second or third generation will also carry the new mutant gene unobscured by any dominant normal from elsewhere. It would therefore be possible to see the mutant effect by looking at these specially marked individuals, provided the effect were visible at all. In about 90 per cent of the cases when flies are used, however, there will be no externally visible effect; the expected marked group of individuals carrying the given treated chromosome simply fails to appear, while the nonmarked individuals do appear. The ratio is, therefore, 0:3 instead of the expected 1:3. This means that the marked individuals were killed before maturity (before they were looked for) by a so-called lethal mutation which had arisen in the chromosome that bore the marker. Different lethals vary in their action and succeed in making their kill by any one of hundreds of refined physiological methods, few of which have been much studied. But at least three or four times as frequent as these lethal cases (and therefore thirty or forty times as frequent as the visible mutations), in flies at least, are those in which the marked class does appear looking about as it was expected to look, but appearing in a lower frequency than 1:3 though not so low as 0:3. This means that some but not all of the marked individuals have died. Such a mutation is called detrimental, although there is no sharp line between the categories of lethals and detrimentals.

Study of the action of a number of visible mutations has made it clear that in the majority of cases the mutant gene has an effect similar to that of the normal gene from which it sprang, but is less active in producing this effect or sometimes even fails to produce it at all. It is probable, therefore, that most of the lethal and detrimental effects simply involve a more or less reduced activity on the part of some one or more of the innumerable biochemical processes of which the organism is constituted, since all these processes are results of the action of the genes that lie behind them. It will be seen from this that the effects of mutations must often be similar to the effects of certain kinds of unfavorable environmental conditions on normal individuals, weakening them in one way or another. The mutant individual, who has been rendered less resistant to the environmental condition in question, is more easily killed by it. Examining the circumstances attending the death of an individual with a detrimental mutation, then, one might be inclined to ascribe the death to environment rather than to heredity and to class the ailment as an induced one. In truth, the death was a product of the combined action of a relatively unfavorable environment and the gene.

A summation of all the mutations discovered by the technique previously described after a dose of 4,500 *r* applied to flies discloses that instead of there being only 1 mutation among 100 offspring, as appeared at first sight to be true, each of the treated germ cells actually carried on the average between 3 and 4 fresh mutations, if visibles, lethals, and detrimentals are included. In the immediate offspring, however, these mutations seldom greatly lower the chances of living, because the mutations from one parent are mostly recessive to the normal genes received from the other parent even if both parents were irradiated. There may well be twice as many mutations as this, say, 8 per germ cell; no attempt has been made to count the lesser detrimentals—those which kill fewer than, say, 20 per cent of the individuals containing them—since such large counts are needed to prove their existence.

In untreated material the spontaneous mutations which occur undoubtedly are of similar types with similar relative frequencies, but the total frequency is only about one hundredth as high as that produced by heavy irradiation. Nevertheless, even this small fraction results in a new spontaneous mutation in one germ cell out of between ten and thirty. This is a sizable ratio, larger than generally realized.

The Eventual Lethality of Most Mutations. It might be thought that since precise genetic techniques are required to make us aware of these mutations, most of the mutations would be practically negligible in their effects on the population. This deduction, however, is entirely fallacious. For although the mutation seldom shows in the immediate offspring, the change in the gene is permanent and the changed gene will tend to persist in an unlimitedly long succession of future generations, until it happens to meet in fertilization a similar gene derived from the other parent. Then it will produce its effect, even though it is still invisible morphologically in the great majority of cases. If it is a fully lethal mutant, the individual in which it appears must die from his hereditary ailment.

On the average, then, each new lethal mutant gene received by an offspring leads eventually to the death of one descendant. More strictly speaking, it is a half cause of death, since the death requires a homologous lethal in the other germ cell in the combination. Since this effect is nonetheless certain to occur in the end, geneticists avoid complication by saying that each recessive lethal eventually causes the death of one genome or single set of genes.

A merely detrimental mutation does not have the same immediate lethal effect when it appears. Suppose it is a detrimental that lowers the chances of survival and further reproduction by only 10 per cent, thus giving a 90 per cent chance of continuance. When this mutation eventually has a chance to show in some distant generation by reason of the combination of two germ cells which carry the same kind of mutated gene, the individual will usually be able to live and reproduce even though he will probably be noticeably handicapped in his living. Usually the gene will then pass through another long line of descendants that do not show the mutation until again two likes come together and it shows once more. Inasmuch as the chance of death from this cause is in the given case only 1 in 10, this process will tend to occur again and again, the mutant gene diving under cover after every reappearance until, on the average, it has had a chance to show itself ten times. Finally it will succeed in causing the death of the individual showing it or it will prevent that individual from reproducing sufficiently to hand down the gene further; in either case, the event may be described as a genetic death. Thus in the long course of breeding, ten individuals scattered here and there throughout many generations show the mutation and are probably hampered by it; but in one of them an effect as disastrous as that of a full lethal is finally brought about. The lethal action has only been postponed, not avoided, and the detrimental effect has been drawn out longer. Similarly, a detrimental gene giving only a 1 per cent reduction in the chances of survival would tend to be passed down until it had shown itself in a hundred individuals before it finally killed one of them or prevented reproduction.

This conclusion is important because it demonstrates that ultimately every small harmful mutation is just as bad as, if not worse than, a fully lethal mutation in its effect on the population. To estimate the total number of genetic deaths finally caused by a group of mutations that were produced at some given time, practically all mutations down to the smallest must be counted. Since, at present, data are available only for lethal and near-lethal mutations and not for the very slightly detrimental ones, the estimates as to the amount of harm done by mutations may have to be revised considerably when more data for mutations of small effects become available. This is a field in which further work is greatly needed.

How Mutations Accumulate. It is, of course, of considerable interest to know the length of time that usually elapses before the recessive mutations produced at any given moment have a chance to show during the course of breeding of an ordinary population in which no special genetic technique has been used, and also to know the average number of generations between one showing of a mutant and the next. This knowledge would assist in the estimation of the effect to be expected in the generations immediately following some widespread exposure, such as that occasioned by the bombing at Hiroshima and Nagasaki.

The answer to these questions will necessarily depend upon the number of such mutations already present in the population. If, for example, 1 in 100 germ cells in a population contains a given type of mutant gene, then a mutant gene of that kind, just produced by irradiation, has a 1-in-100 chance of meeting its mate in the next generation or in any one generation. On the average it will have to pass through 100 generations before it shows, and the average interval between each showing will be 100 generations. (The word "average" implies, of course, that the mutation may show right away even though it has only one chance in a hundred of doing so; it may, on the other hand, pass through a considerably greater number of generations than 100 before it shows.) Therefore, by estimating what the frequency of a given recessive mutant gene in the population is likely to be, one may determine the period between its showings, provided one knows the frequency with which the mutation originates and also how detrimental it has usually been. The accumulation of any given kind of mutation in a natural population is governed by a reaction between two opposite processes that tend to approach an equilibrium, as in the law of mass action in chemistry. The processes here are fresh mutation and elimination. The mutant gene accumulates because it is not only inherited after occurring but also is produced anew with each generation by fresh mutations. This accumulation continues until so many individuals show the mutation and are eliminated by reason of its disability that the rate of its elimination becomes equal to the rate at which it arises by new mutation in any one generation.

In the case of a fully lethal gene which is eliminated on every occasion when it shows, a population that has reached equilibrium for that gene (as most populations will have) must contain a proportion of individuals showing it (and thus eliminated by it) about as high as the proportion of germ cells in which it arises anew with every generation. As an example, suppose that a purely recessive amaurotic idiocy, a condition which is practically certain to lead to genetic death whenever it appears, has arisen by mutation in 1 germ cell in 200,000 in each generation of a given population. (This rate of 1 in 200,000 has been selected because it is near the middle of the range of those mutation frequencies which have already been ascertained for a number of individual genes in man as well as in other organisms.) Assuming this frequency of its origination by mutation, amaurotic idiocy will have accumulated until about 1 person in 200,000 might be expected to show this trait, for then the rate of its origination will equal that of its elimination.

It should be observed, however, that many more germ cells than 1 in 200,000 in the population will carry the trait when 1 person in 200,000 shows it, for the chance of an individual's showing a recessive trait is dependent upon the chance that the gene was in both the germ cells which united to make that individual. The chance is equal to the square of the chance that either sperm or egg, considered separately, contained it, if the usually minor correction occasioned by marriages between relatives is neglected. In other words, if one egg among a given number, x, had the trait, and likewise one sperm among x sperms, then one individual among x^2 would be formed by the meeting of such an egg with such a sperm. In the given case where 1 in 200,000 persons have the defect, 1 in the square root of 200,000, or approximately 1 in 447 eggs and 1 in 447 sperms will carry the gene in question. From this ratio it may be deduced that it would take on the average 447 generations, or about 13,000 years in man, before a given gene for this abnormality, which had arisen by mutation in a given generation, finally came to show itself. Yet, despite this lag, it would on the average show in one individual in the end and would cause his genetic death.

In contrast to a lethal mutation, a merely detrimental one (for instance, a relatively slight hereditary anemia) having the same frequency of origin by mutation (1 in 200,000) would show considerably sooner because it would have accumulated to a higher frequency in the population before being eliminated as fast as it arose. Suppose that this detrimental mutation lowered survival by 10 per cent, having only 1 chance in 10 of being eliminated in an individual who shows it. It is evident that in the case of this mutation there would be ten times as many individuals showing it in the population as were being eliminated by it. Now, since for equilibrium between origination and elimination 1 in 200,000 has to be eliminated in every generation, ten times this number, or 1 in 20,000, must then be showing the detrimental mutation. The ratio of the germ cells in the average equilibrium population which will then contain the gene for this mutation will be 1 in the square root of 20,000, or 1 in 141. The mutation will therefore go through an average of 141 generations, or some 4,000 years in man, before it shows after any given occasion when it originated anew, and the average interval between showings will also be 141 generations.

It should be noted that even a detrimental which lowers survival only 1 per cent and which has a frequency of origin by mutation of 1 in 200,000 turns out to have an interval of somewhat over 1,000 years. So for practical purposes most of the fully recessive genes that could be detected at all must lie latent for thousands of years. This only makes them the more troublesome to find and deal with; it does not lessen the frequency with which they do finally show in any given generation, including the present one.

Dominant mutants, although they may often be irregular in their expression, do not have these long intervals between showings, and are accordingly eliminated more rapidly from the population. Each dominant, however, does as much harm as each recessive and must eventually lead to a genetic death; in fact, it is a full, not a half cause of death. As with recessives, the number of its showings before death occurs is inversely proportional to the amount by which it lowers the chance of survival. But since it is likely that most recessives do have a certain degree of dominance, they may actually show often enough to be eliminated much sooner than calculations made on the basis of pure recessivity would indicate. This, too, is a subject which needs to be studied with much greater exactitude than has been achieved thus far, as it will have considerable bearing on judgments concerning the composition of populations, the average length of time before the effects of mutations are detectable among the descendants of those in whom the mutations took place, and the amount of harm done in the generations immediately following the application of a mutagenic agent.

From the foregoing discussion it can be understood why people are commonly burdened with little ailments and weaknesses of a familial or hereditary nature, since the smaller the detrimental effect of a mutation the more it tends to accumulate so as to show in numerous individuals. If 1 in 10 germ cells contains a new recessive mutation, then one tenth of the individuals in a population at equilibrium must always be dying genetic deaths from such mutations. But only a small minority of these deaths will be due to fully lethal genes. And for all those dying a genetic death by reason of a lesser or detrimental gene, there must be a considerably larger number suffering but not dying from the same ailment.

The problem of mutations, therefore, directly affects practically every individual. Moreover, everyone is carrying latent in him heterozygously a much larger number of genes than those which he shows. A calculation made by Muller on results of inbreeding in man leads to the conclusion that every person at birth harbors heterozygously at least one lethal gene, or a group of genes which in effect act together to destroy an individual who has received it from both parents. This does not take into account the lethal genes which can act at other periods of life.

Implications of Genetic Knowledge in Relation to Environment. The fact that an ailment is hereditary by no means signifies that it cannot be ameliorated or even cured or avoided completely by means of suitable treatment or conditions of living. Heredity and environment do not act in isolation; rather, they interact and jointly determine what a person is at any given age or in any circumstances, in other words, a person's phenotype.

As far as is now known, some genes produce about the same effects in all existing environments. Other genes make the organism react differently in different environments. Thus, the genes which determine the blood groups seem to remain unchanged in all environments that occur in the world naturally or that can be devised artificially by means of drugs or other methods. But the manifestation in the phenotype of the genes that determine the predisposition to tuberculosis or to many other diseases which "run in families" is modified greatly by the environment.

At the present level of genetic knowledge we cannot improve the genes with which we are born, and there is little we can do to determine which genes we pass on to our children. But we can improve the manifestations of our own genes and those of other persons so that the best possible phenotypes are produced. The control of the manifestation of human genes is, of course, possible only by proper manipulation of the environment. The implications as regards medicine, especially preventive medicine, are obvious. As Dobzhansky of Columbia University has put it: "Medicine is the science of management of the human phenotype."

Implications in Relation to the Diagnosis of Disease. Genetic knowledge is also contributing to the physician's ability to diagnose disease. This point was made most forcefully by Snyder in the Hermann M. Biggs Memorial Lecture in 1946:

> It is becoming more and more apparent that the alert physician will find occasional opportunities to make an otherwise difficult diagnosis by taking into account the family history of the patient. . . . In one case a man was admitted to the hospital, having lost considerable blood by hematemesis. The diagnosis appeared to lie between gastric ulcer, cirrhosis of the liver with esophageal varices, and Banti's disease. The appropriate laboratory tests were undertaken, but it happened that the next day one of the attending physicians recalled that the man's father had telangiectasia of a mild type, with typical spider-webbing of the capillaries of the nasal mucous membrane. Since telangiectasia is inherited on the basis of a dominant factor, it occurred to the doctor that perhaps all the patient had was a telangiectatic spot in the gastric mucosa. He explored, found a large telangiectatic focus, and excised it. The symptoms promptly disappeared, and there was no later recurrence of hemorrhage. Employment of available genetic data led to correct diagnosis and hence to proper therapy.
>
> Again, a man had a corn on his foot which had ulcerated. Various physicians whom he consulted were unable to give him any relief. One evening he made a social call upon a distinguished neurologist who happened to be a personal friend, and in the course of the evening hesitatingly mentioned this corn which would not get better, apologizing for bringing such a small matter to the attention of a specialist. To the man's amusement the neurologist

asked for an X-ray of his lumbar spine. He did this because he had formerly treated the man's two brothers for marked trophic lesions which were the result of spina bifida. Sure enough, in this patient an occult spina bifida was found, and was shown to be the cause of the ulceration.*

Implications for Preventive Medicine. Even more impressive are the opportunities which genetic knowledge offers for the detection of hereditary diseases in their preclinical stages when measures can be taken to forestall the appearance of clinical disease. Examples of this application were likewise cited by Snyder.

Although removal of the spleen is a recognized prophylactic procedure for congenital hemolytic icterus, indications for removal are not always obvious, because the principal clinical symptoms—jaundice and a marked anemia—do not invariably appear in those who have the disease. One or another of the laboratory stigmata is, however, always present if appropriate laboratory examinations are made. These signs include a relatively high reticulocytosis for the degree of anemia, microspherocytosis (rarely macrocytosis), increased fragility in hypotonic solutions of sodium chloride, increased icterus index, and enlarged spleen.

It would not be feasible to subject the entire population to laboratory tests to discover who has congenital hemolytic icterus. Because the condition is the result of a dominant hereditary factor, however, it is not only possible but practicable to search for laboratory and preclinical stigmata in places where they are most likely to be found, namely, in the relatives of those patients who have clinically manifested conditions. It is therefore good preventive practice to subject relatives of patients with hemolytic icterus to appropriate laboratory examinations. Then, if a sign denoting the presence of the hereditary factor is noted, the spleen can be removed and clinical disease averted.

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* Laurence H. Snyder: "Medical Genetics and Public Health." *Bull. N.Y. Acad. Med.*, 22:566–587, November 1946.

Snyder also cites the anomaly known as xanthoma tuberosum. Like hemolytic icterus, it has both clinical symptoms and preclinical laboratory signs. The visible symptoms are characteristic nodules and tumors of the tendons and joints. The laboratory signs consist of increases in the blood cholesterol and cholesterol esters. The increase may reach 1,500 mg. per 100 cc. of blood, as compared with a normal blood cholesterol of 150 to 300 mg. per 100 cc. of blood. The condition may progress to cardiovascular involvement and sudden death.

Since the hypercholesteremia is transmitted on the basis of a dominant hereditary factor and since this may be detected by appropriate laboratory tests long before the appearance of visible tumors or nodules, the condition may profitably be sought in the relatives of patients with clinical manifestations. When evidence of the condition is found, preventive dietary and other appropriate measures may help to preclude heart involvement and premature death.

Effect of Health Practices on the Accumulation of Mutations. Unfortunately the prevention of hereditary disease in an individual is not the final outcome of the matter. When the effect of a lethal or detrimental mutation has been ameliorated or rectified, it has, of course, been transformed into what amounts to the effect of a less detrimental mutation. Yet the mutant gene itself will not have been changed, and since credence is no longer given to the doctrine of the inheritance of acquired characters, the gene will be subject to the same laws of inheritance as before. Moreover, the rate of its elimination will automatically be lessened and the equilibrium frequency of individuals capable of showing it in the population correspondingly raised. If the mutation retains any detrimental effect whatever, as it usually will, it must still eventually result in a genetic death, but it will linger longer in the population, affecting more individuals before it dies out. As has been explained, the more reappearances a mutant gene is able to make before it dies out, the more abundant, in exact proportion to this, it eventually becomes in the population. And any mutation which has ceased entirely to become a cause of genetic death is bound to accumulate to an unlimited degree in the population as fresh examples of it arise in every generation, until at last all the individuals of the population come to have this gene from both their parents and it has become established. (Reverse mutations are neglected here, but these would usually be much rarer.) Although such a process takes many thousands of years, its occurrence follows an inescapable genetic law.

It should be recognized that hereditary ills are unlike diseases of other kinds in that by curing one of them today we are creating another case of the same kind for tomorrow. The more success we have, the more does mutation take advantage of the opportunity to encumber the population with these ailments. We have thus largely escaped the effects of the ailment (although an artificial limb or any other kind of patched-up member is seldom as good as a natural one), but only at the expense of continuing to treat a portion of the population which grows ever larger. Mutation, consolidating its victory, then goes on to take the next line of our defense. For we have won no permanent respite, as, pressing the attack, further mutations in the same and other genes now arise to harass the already weakened biological base, and these too accumulate just to the extent that we seem to be successful in parrying them. Offering a finger, we eventually find the whole arm drawn in. There is no limit to this except the complete disappearance of all normal genes by mutation or loss, and by that time, if it were conceivable, we should virtually be making a completely artificial man. If, however, we should stop at any intermediate point, we would thereafter be continually compensating on a widespread scale for all those mutations which had been allowed to accumulate up to that point. And yet we would not have solved the problem of further mutations; these would still be coming up anew at very much the same frequency as they had been when we started our ameliorative procedures. We would then have to decide what to do about them after all, making the decision either to treat them and let them accumulate still further, or to stop at that point and say, "Hereafter, no new harmful mutation will be allowed, so far as we can help it, to perpetuate itself, even though we will treat the individual for its effects."

The day when we make our genetic stand has to come some time, unless we are willing to go all the way to the bottom of the biological hill. Is it not evident that the sooner it comes the better? This does not mean that we should stop trying to find the causes and cures of ailments and impairments, whether hereditary or not, or that we should slacken our efforts to save and improve existing humanity whenever we can. But it does mean that it is up to us to try to discover which ills do have, even in part, a hereditary basis. We should also try to develop means to discourage the accumulation of these hereditary weaknesses through indiscriminate reproduction. In other words, controlled therapy, prophylaxis, and hygiene applied to the immediate generation must be balanced by a certain amount of guidance of reproduction to prevent the ills from piling up for the future.

In order to achieve this balance, we should know the total mutation rate more exactly. If one tenth of our germ cells contain mutations which have arisen afresh in the last generation, not only the lethals but even those slightly detrimental, then that one tenth of the population which is genetically more defective than the others should restrain themselves from reproduction in each generation. (There will be more than one tenth if some of the mutations are dominant because each dominant counts double as a source of genetic death.) However, if our genetic diagnosis can be, say, only 50 per cent perfect, then twice the given proportion, or one fifth, must avoid reproduction in order that such a result may be achieved. Alternatively, their reproduction might simply be somewhat limited instead of being entirely discontinued, but in that case a correspondingly larger proportion of individuals would have to be involved. That is the elementary genetic arithmetic of the situation; the conclusions are, unfortunately, unavoidable and independent of ideologies.

All this calls for the development of our knowledge of human and other genes to a point thousands of miles beyond what it is at present, for, since all of us carry defective genes, what we ultimately want to know is who carries the most and the worst. To that end we need to develop means of recognizing defective genes even in their latent or heterozygous condition, because most of those we carry are in that condition. Only a little progress has been made in that direction, but it is enough to show that the problem is not a hopeless one. Any wise guidance must weigh the especially good genes against the especially bad ones, for it is often worth putting up with temporary difficulties in order to save things which are unusually precious. This policy is particularly advisable because in later generations the bad will usually have a chance to separate itself from the good by the laws of hereditary recombination, and it will then be time enough to allow the bad to be discontinued. Thus the matter of dissuasion from reproduction under some circumstances is bound up with its encouragement under others.

Not only is a great increase in medical and other human knowledge called for in these connections, but a great change in social attitudes will be required before our advancing knowledge can beneficially influence reproductive practices. In the meantime, use should be made of the limited knowledge available to discourage the perpetuation of definitely known hereditary defects while furthering conditions that lend encouragement to the multiplication of hereditary characters that are clearly valuable.

Implications of Genetic Knowledge in Premarital Counseling. Frequently it will be the physician who will be called upon to make a genetic prognosis, for it is to him that many couples turn for premarital advice. In giving such guidance he should be informed regarding the chances of the reappearance of diseases or other traits which have appeared among relatives of engaged couples.

However, not all of the physician's counseling will be concerned with the passing on of mutations which are detrimental in the ordinary sense. Often he will be consulted with regard to the Rh agglutinogen which is inherited on the basis of a dominant gene. Upon him largely rests the responsibility of forestalling the catastrophe which may result when a woman who has not inherited this antigen (termed Rh negative) gives birth to a baby who has inherited it from the paternal side (Rh positive). In this connection, it is a surprising fact that many physicians in the course of their practice actually aggravate the situation. Levine has pointed out that every day physicians are giving blood transfusions to little girls, taking into account only the blood groups and neglecting to test for the presence or absence of the Rh antigen. When these girls reach child-bearing age, any of them who are Rh negative and who have been transfused with Rh positive blood will be so immunized by their transfusions as to increase the hazard that their first babies will be affected with erythroblastosis fetalis; or they may even give birth to congenital monstrosities. Levine urges that, while administering a definitely indicated therapeutic measure, the physician should bear in mind the possible genetic implications of his therapy.

The Production and Avoidance of Mutations. There is another sort of mutational prophylaxis which lies within the physician's domain of responsibility. This consists of measures designed to avoid increasing the frequency with which new mutations occur. Clearly, the more distasteful and difficult it may be to retard the propagation of a mutant gene once it has been brought into existence, the more obligated we are to do what we can to prevent its coming into existence. To be sure, the so-called spontaneous mutations cannot be entirely prevented from occurring, nor is it probable that means will ever be found for greatly reducing their frequency (short of cold cultures of germ cells protected even from natural radiation); but more effective steps can be taken to protect the germ plasm of our population from having additional mutations induced in it by penetrating radiation of artificial origin and other mutagenic agents. This requires, first, a recognition on the part of biologists and physicians that these effects do exist and are of serious consequence, and, second, the cooperation of these men in informing and protecting the public.

Unfortunately many physicians, even in their most authoritative journals, have looked askance upon this subject. Only a few years ago in an editorial in the *Journal of the American Medical Association* physicians were advised to wait until harmful effects could be seen in the offspring of irradiated persons before doing anything about it. Such advice does not take into account the fact that effects which are discernible in the immediate offspring are to be found only with the greatest rarity. Muller predicts that the same largely negative results will be evident even at Hiroshima. For, as has been pointed out with regard to fruit flies, in spite of the fact that fewer than 1 in 100 offspring of an irradiated parent may show a visible mutation, between 3 and 4 lethal or decidedly harmful mutations may be carried unseen in each offspring, and if the flies are allowed to continue breeding, each of these mutations must eventually lead to certain genetic death.

True, the exact frequency of the mutations produced in mammals by a given dose of x-rays is not known—an important deficiency which indicates the need for expensive large-scale experimentation. Yet even the meager experiments already performed on mice are enough to show that the effect is produced and that its frequency is at least of a similar order of magnitude to that of the effect in flies. This is sufficient proof of the argument that precautions must be taken and that they must be on a quantitative basis similar to those used for flies.

To estimate the extent of the effect produced by irradiation, use can be made of the well established principle that the frequency of the mutations induced will be proportional to the total dose of radiation received over an unlimited period of time. It is the total amount of radiation actually absorbed in the tissue that counts, no matter how hard or soft the rays, no matter whether they are given in the form of concentrated and brief treatments or dilute and protracted ones, no matter whether the treatments are uninterrupted or are greatly and frequently interrupted. Unlike many other biological effects of radiation, there is absolutely no threshold dose for this effect; even the most minute dose carries a definite chance of producing mutations, a chance exactly proportional to the size of the dose. That chance, taken by itself, may to all practical purposes be negligible, but it is no longer negligible if it is repeated a number of times so that the total dose becomes important. Just how much is important depends upon our standards. If, as in flies, a total dose of 50 *r* units applied to the spermatozoa results in a mutation frequency about equal to the natural mutation frequency, the combined frequency would be about 1 mutation in from 10 to 20 germ cells, and then the effect would be important. There would be at least a 1-in-20 chance of mutation and therefore this same chance of an eventual genetic death or half-death somewhere along the line of future descendants if the treated germ cells are used in reproduction. On the other hand, in immature germ cells a dose about twice as high as this one is perhaps needed to give an equivalent mutation frequency.

It is important, therefore, that before an irradiation which will reach the germ cells is given, the amount of benefit which it confers should be weighed against the risk of harm to some future individual. If this damage cannot be exactly estimated, it is high time for the problem to be attacked. More generally, anyone who treats a person with radiation should keep account of the total number of *r* units which reach the germ cells. If

100 *r* units double the natural mutation rate in immature germ cells and if this represents a frequency of 1 mutation in 20 germ cells, then twenty times this, or 2,000 *r* units, causing a twentyfold rise, will on the average produce 1 mutation in each germ cell. Thus, this total exposure will be practically certain to lead to a genetic ("genome") death among descendants of persons who reproduce thereafter to an average extent. In other words, if the quantitative relations in humans are like those in flies, radiation should be used with the consideration in mind that every 2,000 *r* units which reach immature germ cells should *in toto* be beneficial enough in their immediate effects to compensate for one certain genetic death in the future. Of course a record of the probable amounts of radiation received by the gonads of each person exposed should be kept for summation. With the greatly increasing use of radiation in medicine, industry, and warfare, this consideration assumes greater importance than it has had previously.

In the light of the foregoing considerations, the use of x-rays as a means of either stimulating or temporarily inhibiting ovulation becomes an indefensible practice, although it is one which has a considerable vogue among some so-called specialists who do not consider a dose of 300 *r* units to the ovaries excessive. Radiologists recognize that on few other occasions is there need to apply much radiation to the reproductive organs of people who still may use these organs. Such persons can be screened from all but a minimal amount of radiation very simply, for example, with lead shields combined with other more ordinary precautions. In view of the scattered radiation that often exists, and especially in view of the fact that certain classes of patients are subjected to irradiation again and again, such shielding ought to be a matter of routine, yet it seldom seems to be so. Whenever irradiation of superficial tissues in the region of the gonads is indicated, Grenz rays should be used instead of ordinary x-rays because of their weak penetration. This practice is as yet far from common, although arrangements for giving x-rays of the Grenz type need not be expensive.

Furthermore, technicians and radiologists themselves, as well as all persons who are frequently in the neighborhood of apparatus for irradiation while it is in action, should be protected by suitable pelvic shields which may, of course, be hidden. This is a minimal mutational prophylactic measure on the part of operators, but it should be an effective one. At present, many technicians have not even been informed that the danger exists; much less do they protect themselves against it.

Turning to another field, one finds in modern commercial practice such usages as the indiscriminate and unregulated x-ray fluoroscopy of the feet of prospective customers, including little children, in shoe stores in positions which undoubtedly allow considerable radiation to reach the gonads. This is a flagrant example of the kind of dangerous misuse of radiation against which decisive measures should be taken.

It should be mentioned that when radiation is applied to mature male germ cells, such as the ones which commonly exist in the testes for weeks before their discharge, there is, in addition to gene mutation, another effect—the breakage and rearrangement of chromosome parts, chiefly of the type called translocations. These are known to lead in mammals (mice) as in other animals to inherited disturbances in germ cell formation which pursue a dominant course of heredity in both male and female descendants for an unlimited series of generations. Unfortunately, even though these disturbances regularly kill off *in utero* about half of the embryonic offspring of individuals who inherit them, they do not tend to die out rapidly in man. Half the offspring who survive show the disturbance when they become mature, and these would naturally tend to compensate for the abnormality in cell formation by more numerous conceptions. The effect is not readily produced by the irradiation of immature germ cells. Even in the spermatozoa the frequency of production is more nearly proportionate to the square of the dose of radiation received than to the dose itself. Thus the effect of low doses (say below 5 *r*) is negligible, the chance of such an effect in mice being only about 1 in 4,500 germ cells at 5 *r*. In mice, however, if only about 100 *r* units are applied to the spermatozoa, 10 per cent of them will carry these changes. It should, therefore, be mandatory for a man to abstain from acts of reproduction for some two months after his testes have been exposed to any considerable dose of radiation. The effect is also produced, although to a somewhat lesser and not yet well determined extent, on ovarian cells at any postnatal stage.

Another point which should be mentioned is the extent to which sterility, inhibition of growth, necrosis, disturbances in the bone marrow and other blood-forming organs, and even cancers and leukemias may be traceable to the somatic effects of irradiation on the exposed individual. There is much evidence that this relationship exists; if it does, the avoidance of these effects might be classed as mutational prophylaxis confined to the treated generation.

In connection with the possible association between cancer and mutation, it should be noted that of the small number of agents known to be capable of inducing mutations—radiations (x-rays, radium, ultraviolet rays), temperature, mustard compounds, dibenzanthracene, methylcholanthrene, and benzpyrene—all, with the exception of the mustards, which have not been sufficiently tested for carcinogenicity, are known to be carcinogenic. This close correlation between carcinogenic and genetic potencies gives support to the hypothesis that cancer may originate as a mutation occurring in a single somatic cell.

Atomic Energy and Mutations. The use of atomic energy, both in war and in peace, has brought a new genetic problem to humanity. The radiations thereby produced are certainly of the types which give rise to mutations, and, as experiments with radium long ago demonstrated, the mutagenic effects must occur with very nearly the same frequency as do those produced by x-rays with a given number of *r* units. That people who survive the effects of an atom bomb may have received hundreds of *r* units has been frequently demonstrated by permanent or temporary sterility as well as in other ways. These people, therefore, must have many mutations in their germ cells. Their reproduction, as well as that of the persons somewhat less severely affected, must be adding to the sum of future human ills. It can readily be estimated that each bomb falling in a highly populous area would probably kill more people in succeeding generations than would be killed at the time of the blast. Moreover, if many such bombs were used, the appreciable amount of radioactive dust which would undoubtedly be carried to distant places would tend to cause mutations in people generally.

Similar considerations would apply to any future peacetime use of atomic energy and of radioisotopes unless most rigorous precautions were taken. Such precautions are, in fact, being used today in atomic energy installations. They will become extremely difficult and cumbersome to enforce, however, when there is widespread use of radioactive material. It will therefore be the responsibility of physicians, working in cooperation with administrators, to see that adequate precautions continue to be taken.

Education of Medical Students in Medical Genetics. Throughout the foregoing discussion, repeated reference has been made to the importance of genetic knowledge in medical practice and the responsibility of the medical profession with regard to mutational prophylaxis. This would indicate the need for physicians to be informed on medical genetics and the need for courses on this subject in the curricula of medical schools.

Sixteen years ago not a single medical school had a course of any sort in medical genetics. In 1947 three schools had required courses, four had elective courses, and others were considering such courses. Moreover, whereas sixteen years ago only two schools included brief considerations of genetics in other courses in the curriculum, in 1947 forty-five schools were presenting material on medical genetics in connection with didactic or clinical courses.

Although progress has been made in introducing medical genetics into the medical curriculum, it should be remembered that only three schools—Ohio State University College of Medicine, Bowman Gray School of Medicine in North Carolina, and the University of Utah School of Medicine—were requiring formal courses in the subject in 1947.

Snyder, until recently Chairman of the Department of Zoology and Entomology at the Ohio State University College of Medicine, has described the course in medical genetics in that institution. A required course has been given annually for the past fifteen years in the third quarter of the sophomore year, at the time the students are having their first contacts with clinical medicine. The course consists of ten one-hour lectures with illustrative patients presented whenever they are available. It is the object of the course to instill in the students a genetic viewpoint and an awareness of the value of knowledge of genetic principles, as well as a factual knowledge of the inheritance of specific anomalies, diatheses, and dyscrasias.

Practical tests of the students' progress are provided by having them answer letters from physicians or patients asking specific questions bearing on genetics. These letters are real communications taken from the files of the Department of Medical Genetics. The students' replies are carefully read, the good points noted and approved, and the mistakes explained and discussed.

Sources of information are listed and critically evaluated, and correct procedures for collecting pedigrees are presented. By the end of the course, the students are able to answer concisely and clearly letters on many topics of genetics, letters which physicians not trained in medical genetics would be embarrassed to attempt to answer. Some examples of the letters presented to the students follow.

Dear Doctor:

I have in my practice a one-year-old male infant who at about five months of age was diagnosed as a Tay-Sachs type of amaurotic idiot. He displays the pale fundi of the lipoid dyscrasias with the typical cherry-red spots. He has developed the progressive blindness and the continual rolling nystagmus that accompanies it. However, he has not as yet shown any of the hypertonicity or spasticity of more extensive brain degeneration. At this time he shows a fairly normal mental development in that he recognizes the parents' voices and obeys certain simple commands. However, this case, as all cases of this type, is probably a hopeless proposition.

The parents are very excitable people who have been nearly frantic over the difficulties of this child. They have been to several other physicians for confirmation of the diagnosis and in search of some possible treatment. However, at present they have fairly well accepted the hopeless situation. The question has now come up as to the possibility of their having future children. They are very anxious to have other children and want to know what danger there is that another child will be born like this one. Will you please give me your advice in this matter?

Yours very sincerely,
________________ M.D.

Students in medical genetics can readily answer the foregoing letter on the basis of their knowledge that amaurotic idiocy is the result of an autosomal recessive gene with complete penetrance and constant expressivity. The chance that any subsequent child will be affected is one in four, even though one affected child has already been produced.

The following letter involves a different genetic prognosis.

Dear Doctor:

I am a girl eighteen years of age. I had two brothers. One died at six years from a hemorrhage diagnosed as hemophilia. The other brother and I are normal and have never shown any unusual bleeding tendency. Now my brother and I each want to marry, and we want to know the chances that either one of us will have hemophilic children. Neither our father nor mother showed any unusual bleeding, but our mother had a brother with hemophilia. Please tell us what our chances are of having children with hemophilia.

Yours sincerely,

The students recognize this case as one which involves sex-linked inheritance, and they correctly answer the letter by pointing out that the brother is completely free from the gene and cannot transmit it, while the girl has one chance in two of carrying it and therefore of having affected sons.

The following letter presents a more complicated problem.

Dear Doctor:

I am writing you for advice on a problem in genetics that is troubling me. It is not convenient at present for me to come for a personal consultation, so I hope you will pardon my asking a question by mail.

Both my husband and I are college graduates. He has his Ph.D. in chemistry and is an extremely well informed person. I have my M.A. in English and have always made excellent records in academic work. We have been married a year and a half and both of us would like a child. We feel that personally we should be good parents. But there is a difficult background.

My sister was an epileptic. She died at thirteen. Mother has two second cousins with epileptic children. Those are the only cases I know about, though a first child of my father's sister is now abnormal through an accident at birth. My father is an obstetrician and has assured me that the child's trouble is due to an unskilled and hasty doctor. My father has told me often that he believes that I have a good chance for healthy children, for there are many of them on both sides of the family. However, he is naturally prejudiced and is not a specialist in genetics.

My parents took my sister to all the big hospitals. Every doctor asked if she had ever been injured. When she was a small child she ran into a door and was unconscious for a long time, so we have tried to believe her epilepsy was traumatic rather than congenital. But with a history of two other cases in the family, I am very much disturbed.

That is the story. I am 34; my husband is 41. Both of us are perhaps too old to plan a family. But we do want one child at least if we can face the future with some degree of assurance. I shall be deeply grateful for your opinion.

Sincerely yours,

In answering this letter, the students draw upon recent knowledge of electroencephalograms and recognize the necessity of testing for cerebral dysrhythmia before giving advice.

Still a different problem is presented by the following request for information.

Dear Doctor:

We have a problem at our house which we would like to ask advice about. Some years ago I was operated on for hemolytic icterus, and my spleen was removed. I have two daughters, and the doctor who operated on me suggested that they should be examined to see if they had the disease too. When he examined them he said that he found signs of the disease in one of them. Her spleen was removed to prevent her from ever having the same trouble I had. Now the question is this. She wants to get married, and since we know this disease is hereditary, we want to know what the chances are of her having children with the disease.

I say that because she has had her spleen removed and the cause of the trouble done away with, she cannot transmit this trouble to her children. My wife and daughter, both of whom studied some biology in college, think that having the spleen removed would make no difference and that the children could have the disease anyway. Please settle this for us and tell us whether having the spleen removed before marriage will make it impossible for her to transmit the trouble to her children.

Yours very sincerely,

Here the student must meet and reject the fallacy of the inheritance of acquired characters. There is also involved the principle of the institution of preventive measures on genetic grounds.

The letter which follows concerns cousin marriage.

Dear Doctor,

I am confronted with a problem that seems both serious and important to me. I took this matter to my family physician, but he did not seem to know about it. He advised me to write to you, and he wants to see your reply as soon as I receive one from you. I will state the facts at this point.

I am a girl 18 years of age and am going with a boy of 21. We have enjoyed going together very much for about a year and have come to the conclusion that we are very fond of each other. We are both in excellent health and attend the same Lutheran Church. The only drastic thing that stands in our way is the fact that we are cousins.

His grandfather and my grandmother were brother and sister which, we figure out, makes us about second cousins. We both know there are a lot of couples who get married and are just as close and even closer in relation and we also know that sometimes the whole family will be in a perfect normal condition and then again it is dreadful to think what some families turn out to be.

In order to be good American citizens we feel it our duty to consult someone that knows more about it than we even suspect. Give us straight facts even if you might realize that we feel certain that we are meant for each other. Would it be possible to receive a reply at once? Your information will be greatly appreciated by both of us.

Thank you,

In cases like this the students learn to suggest inquiry into the family histories of both persons, particularly the part of the history that is common to both, with attention being given to instances of undesirable recessive characters which might have an opportunity for expression by virtue of being carried by both parents.

Even in a short course in medical genetics the basic principles of population genetics can be taught. These principles are so important to an adequate understanding of medical genetics that they should not be neglected. The students in the course at Ohio State University are able to answer letters like the following without too much difficulty.

Dear Doctor:

In our hospital laboratory we have now tested several hundred persons for their Rh factors. We find about 85 per cent positive and 15 per cent negative as others have found. Yet it is stated that Rh positive is dominant to Rh negative. If this is so, why are there not three positives to one negative, that is, 75 per cent positive and 25 per cent negative? Also, if 85 per cent are positive, how can you tell how many are homozygous and how many are heterozygous? Hoping you can help me, I am

Yours very sincerely,

__________________ M.D.

A student with a knowledge of equilibrium proportions and population ratios is perfectly capable of answering this somewhat involved inquiry.

Snyder points out that the foregoing letters are examples of the practical genetic problems which the physician may well encounter. The well read, educated patient expects his physician to be able to guide him in such matters, yet the usual medical training will not provide the basis for answering such inquiries correctly. The solution, according to Snyder, is an organized course in medical genetics in the medical curriculum, taught by a trained geneticist, preferably one who is medically trained as well.

It might further be noted that the education of physicians in this field would contribute to the advancement of the science of genetics. Physicians trained in medical genetics would find hospitals fruitful sources for locating families with hereditary conditions. Individuals who had been patients in such hospitals would welcome further studies of themselves and their families, especially when such investigations were being conducted by the staffs of the hospitals where they had been treated. Hospitals would be able to supply accurate and detailed data pertaining to the conditions of the individuals under investigation. The members of the staffs would also be in an excellent position to secure information from the records of other hospitals where various members of a family under investigation may have been treated.

There is little doubt that the time has come for physicians to take more cognizance of medical genetics. For, as Muller has pointed out, "Mutational effects will go on and become all the more troublesome if, simply because we do not like the problem they raise, we fail to give it official recognition. Nevertheless, mutation has been the saving process that has been behind all biological progress and has brought life to its present estate. Let us then determine that, like fire and like atomic energy itself, it and its effects must eventually be brought under control for our own everlasting benefit rather than to our detriment."

CHAPTER II

The material in this chapter was assembled from addresses by Drs. George Baehr, Past President, The New York Academy of Medicine; John H. Ebbs, University of Toronto Faculty of Medicine; Winslow T. Tompkins of the Nutrition Research Clinic, Philadelphia Lying-In Hospital, Pennsylvania Hospital, Philadelphia; and Josef Warkany, Children's Hospital Research Foundation, Cincinnati; and from discussions of these papers by Drs. Carl T. Javert, Assistant Professor of Obstetrics and Gynecology, Cornell University Medical College; Oliver H. Lowry, Public Health Research Institute of the City of New York; Harold C. Stuart, Associate Professor of Child Health, Harvard University School of Public Health; and Howard C. Taylor, Professor of Obstetrics and Gynecology, College of Physicians and Surgeons, Columbia University.

Maternal Health and Nutrition: A Problem in Preventive Medicine

In 1930 the puerperal death rate in the United States was higher than that in most civilized countries. Moreover, this high rate had persisted almost unchanged for a good many years despite the fact that modern obstetrics had evolved into a highly specialized department of medical practice. Not even in communities like the city of New York, where hospitalization for childbirth was higher than in most other places, was there any evidence of a decline in deaths from puerperal causes. To all appearances the curve of the maternal death rate had reached a plateau.

This was the situation when the Committee on Public Health Relations of the New York Academy of Medicine, under a grant from the Commonwealth Fund, undertook its now famous study on maternal mortality in New York City.* During a two-year period every death of a woman in childbirth in the city was thoroughly investigated; physicians, midwives, and members of the patients' families were interviewed, and hospital records were examined. As a result of this painstaking research, the Committee arrived at a challenging conclusion: of the 2,041 deaths studied, 65.8 per cent were preventable. Of the 1,343 preventable deaths, the Committee was of the opinion that 61.0 per cent could be charged to errors in technique or judgment on the part of the attending physician.

The medical profession accepted the challenge of this report. Today in each of the five county medical societies within New York City a committee on maternal mortality sits in judgment on every maternal death. Adoption of this procedure and other recommendations in the report has brought results which amply justify its conclusions. Within ten years after the report was published the puerperal death rate in New York City had dropped more than 66 per cent. Further decreases in puerperal mortality have since been brought about by the use of the new antibiotics. Other communities have also followed the recommendations of the report, so that all over the country there has been a substantial decline in the long-static maternal death rate.

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* New York Academy of Medicine, Committee on Public Health Relations: *Maternal Mortality in New York City*, New York, The Commonwealth Fund, 1933.

Now that the hazard of the delivery-table has been reduced, emphasis is being placed on the antepartum period. Efforts are being made to educate prospective mothers concerning the health practices they should follow during their pregnancy. At the same time, investigations are being carried out to discover what are the best practices in this care, for not enough scientific knowledge is available in this field.

The Role of Nutrition in Pregnancy. One of the obvious points of attack in any program of antepartum care is the improvement of the dietary habits of pregnant women. Although the exact relationship of the nutritional status of pregnant women to maternal and infant health is not known, there can be no doubt that such a relationship does exist. Evidence of this on a large-scale basis was forthcoming during the second world war. During the siege of Leningrad, when expectant mothers underwent severe hunger, the incidence of stillbirths and premature births rose, the weight of newborn infants decreased, and the generally lowered vitality was accompanied by an increased morbidity in the postnatal period. On the other hand, in the mining districts of Wales where the diets of pregnant women were greatly improved during the war, there was a sharp fall in the rate of stillbirths.

In order that the role which nutrition plays during the antepartum period may be determined more precisely, several research projects have been undertaken in the United States and Canada, including studies at the University of Toronto, Philadelphia Lying-In Hospital affiliated with the Pennsylvania Hospital, the New York Lying-In Hospital, and the Harvard University School of Public Health. Laboratory studies on animals are also being carried out, notably at the Children's Hospital Research Foundation in Cincinnati. Some of the results of these investigations will be detailed here.

That the dietary habits of the mother are related not only to her condition during pregnancy, labor, and convalescence but also to the condition of her baby has been demonstrated by the studies made at Toronto, Philadelphia, and Harvard.

In the University of Toronto study, which was terminated by the war, the subjects were selected from women of low income who had not reached the end of the sixth month of pregnancy and who had been maintaining a poor diet. The diet was judged on the basis of a record of everything consumed during one week. Alternate patients were left on their inadequate diets to serve as controls; the others, referred to as the "supplemented diet group," were given extra foods until six weeks after their delivery.

Although the figures in the Toronto study are too small to be statistically significant, they are confirmed by the more extensive studies in Philadelphia and at Harvard.

Data are available on 90 women of the supplemented diet group and 90 women of the control group. The number of primiparas in these groups was the same, and the groups were also fairly well matched with regard to the number of major complications which had been experienced in previous pregnancies. The rate of complications was high; 50 per cent of those who had had previous pregnancies had a history of miscarriage, stillbirth, premature birth, or toxemia of pregnancy.

The average duration of antepartum observation was about four and one half months. The extra foods given to the supplemented diet group consisted of 30 ounces of milk daily, one egg daily, 32 ounces of canned tomatoes weekly, one half pound of cheese weekly, seven oranges weekly, one viosterol capsule containing 2,000 units of vitamin D daily, and 2 tablespoonfuls of a palatable form of wheat germ daily. Instructions were given for planning the remainder of the diet on the available income. Records of food consumption after the supplemented diet had been put into effect showed that the average daily consumption of calories had increased from 1,690 to 2,424, protein increased from 56 gm. to 94 gm., and calcium from 0.56 gm. to 1.61 gm. In a number of cases an actual check of the food in the home indicated that a reasonably accurate record was being kept by the mothers.

From the evaluation of the effect of improved nutrition on maternal and infant well-being which has been carried on in the Nutrition Research Clinic of the Philadelphia Lying-In Hospital since 1935, statistical data are available on 593 subjects. For comparative purposes, similar information has been compiled for the year 1939 on 772 obstetric patients not in the research group. Women who were admitted as emergency patients and those who had not made two or more antepartum visits were excluded from the control group; all cases of nonviable fetuses and all Negro patients were excluded from both groups.

The patients attending the Research Clinic are given intensive and persistent instructions, both written and oral, concerning the dietary habits they should follow. These instructions are based upon a minimum optimal diet which varies with the weight of the patient at the beginning of pregnancy. For the average patient of 129 pounds, the daily diet contains 2,200 calories, including 110 gm. of protein (of which approximately 80 gm. are animal protein), 85 gm. of fat, and approximately 300 gm. of carbohydrates. Patients are instructed to eat six small meals a day at approximately three-hour intervals, to restrict fruit and fruit juices to two servings daily, to limit total fluid intake to eight glasses a day, and to refrain from eating pastry, ice cream, candy, and nuts.

The study at the Harvard University School of Public

Health is being made in connection with a research project on the growth and development of infants and children. In the course of investigations of development during the fetal period, maternal dietary histories over the past sixteen years have been rated as excellent, good, fair, poor, or very poor, in accordance with nutritional standards.

These three studies permit a comparison between women who have maintained good diets during at least part of their pregnancy and women who are poorly nourished, with respect to their condition during the antepartum and postpartum periods, their experience during labor, and the results of their pregnancies.

Antepartum Period. A comparison of the two groups in the University of Toronto study as to their condition and symptoms during the antepartum period is indicated in Table 1.

Table 1. Complaints and Disturbances during Antepartum Period of 90 Women in Supplemented Diet Group and 90 Women in Control Group

	Control Group	*Supplemented Diet Group*
Numerous complaints	24	14
Anemia	24	15
Toxemia	13	9
Hemorrhage	10	6
Pyelitis	5	3
Severe vomiting	1	1

It has been emphasized that these figures do not indicate in full the improvement brought about by the supplemented diet. Women who had been on this diet for only a short period showed such a change in their outlook on the pregnancy itself and on life in general that an improvement in attitude and bearing was readily evident to those in charge of the clinic.

Statistical data from the study at the Philadelphia Lying-In Hospital show that there were no cases of pre-eclampsia or eclampsia in the group of women who followed the prescribed diet as against 12 (1.56 per cent) cases of pre-eclampsia and 1 of eclampsia in the control group. It has also been reported that the prescribed regimen of six small meals a day substantially decreased the severity of the nausea and vomiting of early pregnancy and aided in the elimination of fatigue and other symptoms associated with energy depletion.

In the Harvard studies, also, a relationship was found to exist between the dietary rating and the course of pregnancy. The differences in the incidence of toxemia were particularly striking. Of 28 cases of toxemia which occurred among the women in this study, none was in the group of women whose diets had been rated good or excellent; 2 cases were in the fair diet group, and the rest occurred among women who had maintained poor or very poor diets.

Labor. The differences between the experiences during labor of the women in the supplemented diet group and those of the controls in the University of Toronto study are shown in Table 2.

Table 2. Abnormalities during Labor of 90 Women in Supplemented Diet Group and 90 Women in Control Group

	Control Group	*Supplemented Diet Group*
Prolonged, difficult	16	5
Hemorrhage	10	9
Premature	5	2
Miscarriage*	4	1
Stillbirth	3	1

* Validity of these figures is questionable since many of the patients did not come under observation until the sixth month of pregnancy when the period for miscarriage had passed. "Miscarriage" as used in this table refers to abortion occurring in the fourth, fifth, and sixth months of pregnancy.

The experience of the Philadelphia Lying-In Hospital was also significant, the rate of premature births being 70 per cent higher and the rate of stillbirths 38 per cent higher for the women in the control group than for those who followed the prescribed diet.

In the Harvard study, no correlation has been found between the dietary rating and the duration of labor. Women in the poor diet groups, however, had many more complications during labor and delivery despite the fact that their babies were, on the average, nearly three pounds lighter than those of the women who had been maintaining proper diets. Moreover, all of the 5 stillbirths and 8 of the 9 premature births occurred among the women whose diets had been rated very poor.

Postpartum Period. The symptoms and illnesses which were recorded for the two groups of women in the Toronto study during their convalescence in the hospital and six weeks after their delivery are shown in Table 3.

Differences between the women in the two groups were also noted with respect to their ability to nurse their babies. Two weeks after delivery 93 per cent of the babies of the supplemented diet group were breast-fed as against 91 per cent in the control group; at the end of six weeks this difference was more significant, the rates being 78 per cent for the supplemented diet group and 53 per cent for the control group.

Condition of the Infant. The relationship between maternal nutrition and infant health has also been the subject of investigation, and the findings on this point have been as striking as those relating to maternal health.

The figures on stillbirths, miscarriages, and premature births which have already been cited apply, of course, to the fetus and infant as well as to the mother, so that on these scores alone it can be said that the nutritional status of the pregnant woman has an effect on the result of her pregnancy. The studies at the Philadelphia Lying-In Hospital show that the rate of

Table 3. Complaints and Disturbances during Postpartum Period of 90 Women in Supplemented Diet Group and 90 Women in Control Group

	During Convalescence in Hospital		Six Weeks After Delivery	
	Control Group	*Supplemented Diet Group*	*Control Group*	*Supplemented Diet Group*
Anemia*	23	11	8	0
Fever	11	10		
Pelvic inflammation	9	3		
Breast inflammation	5	2		
Phlebitis	2	1		
Hemorrhage	1	0	3	1
Cervicitis, vaginitis			5	1
Numerous complaints			7	4
Miscellaneous			6	4

* Hemoglobin below 65 per cent.

neonatal deaths was 15 per cent higher for infants whose mothers were in the control groups than it was for those whose mothers had adhered to the prescribed diet. Of the 3 neonatal deaths in the Harvard series, 2 were in the group whose diet was classed as very poor.

Table 4 compares the condition of the two groups of babies in the Toronto study.

Here again, Ebbs states that statistical data cannot express adequately the difference between the two groups. This difference was so marked that it was possible, by looking at the baby, to tell with reasonable accuracy the group to which the mother belonged.

The Harvard study shows that the weight, length, and osseous development of babies at birth are related to the diet of

Table 4. Symptoms and Disturbances among Infants Born to 90 Women in Supplemented Diet Group and 90 Women in Control Group

	Control Group	*Supplemented Diet Group*
Slow progress	16	4
Fever	2	1
Difficult resuscitation	2	0
Convulsions	1	0
Skin infection	0	1

their mothers during pregnancy. Seventy-seven per cent of the babies born of mothers whose diets were considered poor to very poor weighed less than 7 pounds at birth as against 6 per cent in the good and excellent diet groups; 74 per cent of the babies whose mothers' diets had been rated poor or very poor were under 50 cm. in length in contrast to 10 per cent under that length in the good and excellent diet groups. Analysis of the maternal diets in relation to their protein content showed that there was a progression upward in the weight and length of babies at birth as the protein content of the maternal diets increased. Babies whose mothers had diets rated excellent for protein were, on the average, 2 pounds 10 ounces heavier and 5.7 cm. longer than were those born to mothers who had maintained diets with low protein content. A similar association was noted between the protein level of the maternal dietary and the osseous development of the baby at birth, and, to a somewhat lesser extent, osseous development was found to be related to the amount of calcium in the mother's diet.

Animal Experiments. More exact studies of the relationship between specific elements in the maternal diet and the condition of the offspring can, of course, be made with animals than with human beings. At the Children's Hospital Research Foundation in Cincinnati, Josef Warkany has demonstrated that the lack of certain vitamins in the diets of female rats results in malformations in their young. Thus far he has identified three substances which by their presence or absence in the maternal diet can determine the structural formation of the rat.

In Warkany's experiments, the males were kept on an adequate stock diet. The females, moreover, were not starved in the usual sense of the word; they were permitted to eat as much and as often as they wanted, but certain elements in the stock diet were omitted from their food. In order to make certain that the abnormalities of the offspring were not due to genetic factors or to the season of propagation, animals of the same derivation which had been fed a stock diet were bred at the same time. Since these controls invariably bred normal young, any malformations in the experimental group could be attributed to nutritional deficiencies.

Diet I, consisting of corn meal, wheat gluten, calcium carbonate, and sodium carbonate in definite proportions—a rachitogenic diet—was supplemented with viosterol to prevent rickets. Of the 761 offspring of females reared on this diet, 244 or 32 per cent were anatomically abnormal. These abnormalities took the form of short mandibles, short extremities (particularly short tibias), syndactylism, fused ribs, and, frequently, protruding tongues and cleft palates.

Further experiments showed that an addition of 2 per cent dried pig liver to Diet I prevented these abnormalities. A search was then made for the preventive factor. Diet I supplemented by such substances as liver ash, casein, cod liver oil, and wheat germ oil was tried to no avail; abnormal offspring were produced. Finally, after tests with five crystalline B complex vitamins—riboflavin, thiamine, niacine, pyridoxine, and calcium pantothenate—the preventive for the deficiency malformation was found to be riboflavin.

Diet R was like Diet I except that vitamin D was omitted from it and dried pig liver added to it. Young rats fed on this diet developed rickets. Moreover, this experiment showed that rats born of mothers fed on Diet R can develop rickets congenitally. Of the 248 offspring of females reared on this diet, 112 or 45 per cent were born with bowed radiuses, ulnas, tibias, and fibulas. When this rachitogenic diet is supplemented with viosterol, only normal young are obtained; viosterol in the diet of mother rats is therefore a preventive for the development of congenital rickets among offspring.

A third dietary experiment carried on by Warkany and his associates concerned the effects on young rats of maternal diets which were deficient in vitamin A. Hale's experiments on pigs had demonstrated that microtia, anophthalmus, and other congenital malformations appeared in offspring of sows which had been fed on diets lacking in vitamin A.* Rats, however, cannot be raised on a diet from which this vitamin is completely absent. Accordingly, Warkany fed his experimental female rats a diet consisting of ground whole wheat, crude casein, brewer's yeast, sodium chloride, and vitamin D to which a small amount of carotene was added until the rats reached maturation.

Of 820 young rats born under these conditions, 612 (75 per cent) had abnormalities of the soft tissues; abnormalities in the eye have to date been the ones most thoroughly investigated. The most characteristic abnormality seems to be a retrolental membrane in place of the vitreous humor. Other anomalies frequently found are fusion of the cornea with the lids and a rudimentary iris with no anterior or posterior chamber. Other abnormalities have been found in the chest: a spongy heart, a pleura which remains fetal and does not migrate forward, and a liver lobe extending into the pleural cavity and causing diaphragmatic hernia. Horseshoe kidneys and undescended testes and ovaries also seem to be congenitally linked with vitamin A deficiency.

These experiments demonstrate that in rats specific deficiencies in maternal diets are directly responsible for abnormalities in the offspring. Moreover, when maternal diets are such that congenital malformations might be expected, a great many of the young die *in utero*. The conditions of these experiments do not, of course, resemble conditions in man, but they do bring out many significant points concerning possible relationships between maternal nutrition and infant health among human beings.

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* Fred Hale: "The Relation of Vitamin A to Anophthalmos in Pigs," *Am. J. Ophth.*, 18:1087–1093, 1935.

Nutritional Deficiencies at the Beginning of Pregnancy. In contrast to the diets fed to Warkany's rats, human diets are not ordinarily totally deficient in any of the important nutrients. Nevertheless, deficiency states of a subclinical type have been found to be extremely frequent among the patients at the Nutrition Research Clinic of the Philadelphia Lying-In Hospital. Table 5 shows the incidence of objective and subjective observations suggestive of nutritional deficiencies as found among the 165 patients attending this clinic in April 1947.*

The correction of already existing deficiencies appears to be one of the first steps in a program directed toward adequate nutrition of pregnant women. Winslow T. Tompkins of the Division of Obstetrics and Gynecology of the Philadelphia Lying-In Hospital stated that the degree of nutritional inadequacy at the beginning of pregnancy will determine the degree of deficiency which can be expected to develop should dietary habits remain unchanged. A patient whose nutrition is adequate at the beginning of pregnancy and who maintains a satisfactory dietary regime is better able to withstand the depleting effects of early nausea and vomiting and the increasing metabolic demands of late pregnancy. On the other hand, the patient who begins her pregnancy showing definite signs or symptoms of deficiency and whose nutritional intake continues

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* In another of the studies under discussion—the one at the Harvard University School of Public Health—the rate of discovered symptoms of malnutrition is much lower than that found at the Philadelphia Lying-In Hospital.

Table 5. Incidence of Objective and Subjective Signs of Nutritional Deficiency among 165 Pregnant Women

Symptoms	*Number of Patients*	*Per Cent of Total Patients*
Glossitis	162	98
Gingivitis	136	82
Cheilosis	5	3
Stomatitis	5	3
Fatigue	115	70
Weakness and pain in legs	90	55
Gastrointestinal hypotonia	85	52
Weakness	74	45
Anorexia	73	44
Constipation	61	37
Dyspnea and palpitation	60	36
Irritability	53	32
Weakness and pain in arms and hands	33	20
Burning of feet	32	19
Insomnia	28	17
Muscular weakness	19	12

to be inadequate will show distress to an increasing degree, depending on the severity and velocity of the nutritional lack.

The evidence that deficiency states of minor degree are frequent has emphasized the importance of supplementing with vitamins the nutritional elements obtained from natural food sources. Tompkins recommends that this supplementation consist of a relatively high potency polyvitamin concentrate. He emphasizes, however, that the concentrate should be taken in addition to, not instead of, an adequate diet.

Changes during Pregnancy. The importance of the nutritional status at the beginning of pregnancy should not be underrated. Even if a woman is in nutritional balance at the beginning of her pregnancy and continues to maintain a diet which has been adequate for her prepregnant needs, there is no assurance that complications associated with nutritional deficiency will not develop. For the pregnant woman is not a static organism; she is changing month by month. Her nutritional requirements are likewise in a constant state of flux, and an optimal diet during the second month of pregnancy might not be sufficient during the eighth month.

For this reason, various research projects are under way to determine more exactly the physiological changes which take place during the period of pregnancy and the implications of these changes with relation to diet.

Gain in Weight. Carl T. Javert and others at the Nutrition Clinic of the New York Lying-In Hospital have determined the normal weight curve for women of varying weights at the beginning of their pregnancies. On the basis of these calculations, the average weight gain in pregnancy has been estimated to range from 15 to 25 pounds. Not only is the weight curve a fairly good index of a patient's nutritional status, but both the Philadelphia and New York studies indicate that an unusual rise in weight may be prognostic of pre-eclampsia.

Every effort is made at the Philadelphia clinic to keep the weight gain within prescribed limits—one half pound per week during the second trimester of pregnancy and one pound per week during the third trimester until about the thirty-seventh or thirty-eighth week; after this time the weight usually remains constant or decreases slightly. Since excessive ingestion of fruit and fruit juices, entailing the intake of large amounts of fluid and sugar, has been found to be associated with gain in weight, consumption of these items has been limited to two servings daily. Further precautions include the barring of pastry, candy, ice cream, and nuts from the diet except in occasional instances after the patient's weight has been satisfactorily stabilized. If at any time during the pregnancy the weight gain is excessive, intensive efforts are made to restore nutritional stability, even to the point of hospitalizing the patient if this is thought to be necessary. As Tompkins points out, it is more expedient to hospitalize patients early for restabilization procedures as a preventive measure than to wait until a severe catastrophe occurs which will require prolonged hospitalization and not infrequently the termination of pregnancy.

Basal Metabolic Rate. Most authorities agree that the basal metabolic rate increases during pregnancy. At the New York Lying-In Hospital clinic it has been observed that the percentage increase in the basal metabolic rate is similar to the percentage rise in weight. The basal metabolic rate is either normal or slightly below normal at the beginning of pregnancy, begins to rise during the second trimester so that at term it is, on the average, approximately +10, and thereafter returns to the normal level again.

Protein Requirements. The increase in the basal metabolic rate makes essential a caloric intake which includes sufficient energy-producing and tissue-protective foods. In particular, clinical evidence would indicate that there is a special need for additional proteins, since several of the disorders associated with pregnancy have been charged to an inadequate supply of this element. Tompkins is of the opinion that hypoproteinemia is one of the primary causes of edema associated with pregnancy. Moreover, since hypoproteinemia is a major factor in the production of hydremia and since secondary, or simple, anemias of pregnancy are usually stated to be the result of physiological hydremia, Tompkins believes that the secondary anemias of pregnancy are the result of hypoproteinemia and the associated general undernourishment. It has already been pointed out that there is a seeming correlation between the protein level of the maternal dietary and the weight, length, and osseous development of the child at birth.

Cell Volume and Hemoglobin. Monthly determinations of the hemoglobin and cell volume percentages of a series of pregnant women made at the New York Lying-In Hospital clinic indicate that during pregnancy there is a more or less normal decrease in both, so that immediately prior to delivery the average hemoglobin is 80 per cent and the average cell volume

35 per cent. In order to counteract the anemia associated with these decreases, iron supplements are given in the middle third of pregnancy with the result that the hemoglobin and cell volume of patients so treated rises instead of declining. Since these women have no other therapy, the fact that the incidence of eclampsia and pre-eclampsia in the group so treated is only 1 per cent as against a 5 per cent incidence among the other patients in the clinic suggests that the iron was responsible for the better showing.

Tompkins, on the other hand, believes that the anemias of pregnancy, except when accompanied by blood dyscrasias, are typical nutritional anemias which will not respond to iron therapy alone. He points out that according to dietary surveys at the Philadelphia Lying-In Hospital, there is a direct correlation between hemoglobin levels and protein levels. Nutritional therapy is therefore indicated, and recent observations at this clinic suggest a more marked and a prompter response when iron therapy was omitted and desiccated liver was administered.

Tompkins also disagrees with those who consider folic acid an agent in the prevention of the simple hypochromic anemias of pregnancy. Folic acid, he points out, has not been demonstrated as being effective except in the presence of true macrocytic anemia, and, since macrocytic anemias are rare in pregnancy, the indications for the use of folic acid are infrequent.

Vitamin C Level. Monthly determinations of the vitamin C level in the blood, made at the New York Lying-In Hospital, reveal that nonpregnant patients have a level of about 1 mg., while, at term, the level for pregnant women is about 0.3 mg. Since a level of 0.5 mg. or less of vitamin C in the blood is, according to present interpretation, indicative of a deficiency, many so-called normal pregnant patients are in reality subnormal with respect to vitamin C. It has been found that many of the patients at the New York Lying-In Hospital who suffer from threatened or habitual spontaneous abortion show, in the first four or eight weeks of pregnancy, no vitamin C in the blood. Moreover, a fairly large number of patients who have had several miscarriages have, when treated with vitamins C and K in addition to an adequate nutritional program, finally succeeded in having full-term normal infants.

Prothrombin Level. There are as yet no chemical means available for assaying vitamin K in the human body. An indirect approach to the determination of vitamin K deficiency can be made, however, through measurement of the prothrombin level. If there is an adequate amount of vitamin K present and the liver functions normally, the prothrombin level is expected to be normal; conversely, an inadequate supply of vitamin K would result in an abnormal prothrombin level.

The prothrombin curve, as adduced from monthly studies of pregnant patients at the New York Lying-In Hospital, shows none of the wide fluctuations which are characteristic of the vitamin C and hemoglobin curves. Rather, its range tends to lie between 85 and 95 per cent of normal, and many patients maintain a completely stable level of 100 per cent. From this observation it has been deduced that women in normal pregnancy do not necessarily require a vitamin K supplement. There is, therefore, no basis for the routine administration of vitamin K to all pregnant women—a measure which has been widely adopted in recent years.

When it is necessary to administer vitamin K or any of the other fat-soluble vitamins, the patient should be warned against taking mineral oil except, perhaps, at bedtime. Javert cites the case of a woman whose prothrombin level stayed in the neighborhood of 70 per cent of normal despite frequent oral administrations of vitamin K; yet intramuscular injection of the vitamin brought results. The subsequent discovery that the patient had been taking mineral oil accounted for this apparent paradox.

Factors in Nutritional Deficiency Other than Diet. An adequate diet does not, of course, insure adequate nutrition. One of the objectives of any nutritional program for pregnant women, therefore, is to institute measures which will, insofar as is possible, insure to patients the full benefit of the food they consume.

Among the patients at the Nutrition Research Clinic of the Philadelphia Lying-In Hospital a typical syndrome, characterized by fatigue, lassitude, mild depression, and general physiological hypotonia, frequently develops during the middle or latter part of the second trimester. Since this syndrome has been found in patients known to be adhering to the dietary instructions given at the clinic and since patients of this type have made a prompt and satisfactory response to parenteral therapy with B-complex vitamins, the indication is that a failure in absorption from the gastrointestinal tract is largely responsible for the nutritional imbalance. For this reason, administration of vitamin supplements by the parenteral route is recommended.

Another deterrent to proper nutritional balance is the vomiting which is so frequently associated with pregnancy. As has been pointed out, the experience in the Philadelphia Lying-In Hospital has demonstrated that a regimen of six small meals a day at approximately three-hour intervals decreases the severity of vomiting during early pregnancy. In the New York Lying-In Hospital it has been noted that some patients have a recurrence of nausea, vomiting, and heartburn during the third trimester of pregnancy. Examination has revealed that this is not infrequently connected with hiatus hernia, particularly in multiparous women.

Other Factors in Complications of Pregnancy. From the studies at the University of Toronto, the New York Lying-In Hospital, the Philadelphia Lying-In Hospital, and the Harvard University School of Public Health it is obvious that there is a definite and by no means negligible correlation between the nutritional status of a pregnant woman, on the one hand, and her health and the condition of her baby, on the other. This does not mean, however, that all disorders connected with pregnancy should be ascribed to nutritional imbalance or that disturbances which may at times be charged to this type of deficiency are always directly related to it. Harold C. Stuart of the Harvard University School of Public Health presents data which strongly suggest a correlation between diet and toxemia of pregnancy, but at the same time he points out that one must deal cautiously with any assumption concerning such a relationship. Javert, in citing instances in which vitamin therapy seemingly controlled spontaneous abortion, describes one case in which this type of treatment was of no avail, the abortion being caused by a torsion of the cord. As Stuart has put it, "It may be said without any reasonable doubt that an association exists between the maternal dietary and the consequences of pregnancy. It should be emphasized, however, that at present the nature of this relationship is either entirely unknown or extremely obscure."

Need for Research. The uncertainty concerning the exact relationship between nutritional status and pregnancy predicates the need for an extension of research. In particular, biochemical research is indicated, for biochemical tools may some day make it possible to diagnose mild subclinical deficiencies which are not severe enough to produce definite lesions, but which may at times of stress, such as pregnancy, predispose to illness.

Studies at the Public Health Research Institute of the City of New York have recently produced mechanisms for measuring most of the nutrients in either the urine or small samples of blood from the fingers. To use such tools, however, it will be necessary to know in what way the blood or urine level for each nutrient is associated with the optimal amount of that nutrient in the body; that is, concomitant with the studies of blood and urine levels, there must be studies of the physiology of the various nutrients.

Progress in the development of biochemical indices has already been achieved, and there is reason to hope that eventually it will be possible to assess nutritional status through the measurement of the essential substances in the appropriate body fluids. The chemical laboratory is becoming more and more an important adjunct to the antepartum clinic where research in nutrition is being carried out. This has been evident in the descriptions of several of the projects which have been undertaken at the Nutrition Clinic of the New York Lying-In Hospital, where the chemical laboratory has been frequently utilized.

Need for Educational Activities. Although the relationship between specific nutrients and complications of pregnancy is not fully understood, considerable evidence is at hand concerning certain of the nutritional elements which are important in meeting the increased demands of pregnancy. Present efforts, therefore, should not be confined to scientific research alone, but should be extended to include a broad educational campaign directed toward all prospective mothers.

The obvious place for instituting an educational program is the antepartum clinic. On the basis of the experience of the Nutrition Research Clinic of the Philadelphia Lying-In Hospital, Tompkins has made suggestions as to how such a program should be conducted. In the first place, the dietary prescribed must be practical and palatable, one which the patient may be expected to eat. For example, since it is almost impossible to construct a palatable diet with less than approximately 2.5 gm. of salt per day in it, the restriction of salt is not recommended except in individual instances. Secondly, persistent personal supervision is required. The simple expedient of giving a patient a printed dietary outline, or telling her to eat a well balanced diet, cannot be expected to achieve results. But by dint of intensive and frequently repeated dietary instructions, both written and oral, Tompkins has found that cooperation can be obtained, except for the few patients who are unable to understand, who cannot for some vague reason conform, or who refuse to cooperate.

Educational efforts should not be confined to clinic patients, who might be expected to maintain below-average dietary standards. Ignorance is as much of a deterrent to proper nutrition as is low income, and ignorance is not confined to those who attend outpatient departments. The studies at the New York Lying-In Hospital show that many patients with vitamin C deficiencies have an adequate income; they are the so-called meat-and-potato eaters who have no fruit juices or fresh vegetables in their diet. The correction of their habits, many of which have been formed in childhood, is as much a part of the educational program as are efforts to improve the diets of those whose unwise selection of foods can be charged in part to financial stringency.

Moreover, the campaign should not deal solely with pregnant women. Stuart cites the case of a woman who had followed the dietary instructions of her obstetrician but whose baby had skeletal defects which were suggestive of nutritional deficiency. Investigation of her past nutritional history revealed that, until her pregnancy, she had not consumed milk since early in her childhood. It must be remembered that an adequate diet during pregnancy cannot be relied upon to equalize in full dietary lacks which have been in existence over a number of years. The success of the campaign for the elimination of maternal nutritional deficiencies therefore depends to a certain extent upon the formation of proper food attitudes among children as well as child-bearing women.

In both aspects—research and education—the program to improve maternal and infant health through optimum nutrition is part of a broader program that should be directed toward the population at large. Scientific investigation is called for not only to determine the dietary requirements peculiar to pregnancy but also to develop techniques for the determination of subclinical nutritional deficiencies in all human beings. A particular effort must then be made to induce all pregnant women to adopt diets in line with the knowledge available. At the same time, if the program is to attain its complete objective, all people must be encouraged to maintain diets consistent with maximum health and well-being.

CHAPTER III

The principal contributors to this chapter were Willard H. Wright, D.V.M., Chief of the Division of Zoology, United States Public Health Service; and Drs. Fred L. Soper, Director of the Pan American Sanitary Bureau; Henry E. Meleney, Professor of Preventive Medicine, New York University College of Medicine; John C. Snyder, Professor of Bacteriology, Harvard University School of Public Health; Morris Greenberg, New York City Department of Health; and Wilson G. Smillie, Professor of Public Health and Preventive Medicine, Cornell University Medical College.

Animal and Insect Reservoirs of Disease

MAN's comprehension of reservoirs of disease in the lower animals was undoubtedly acquired long before scientific data were developed to support his empirical observations. Certain parts of the Mosaic law were no doubt based on the sad experience that the consumption of pork was in some instances followed by serious illness.[1] However, it was not until some thirty-three hundred years later, when Leidy in his Philadelphia laboratory became curious concerning the grayish-white deposits among the fibers of the ham of his luncheon sandwich, that the first factual evidence was obtained to incriminate the hog as a reservoir of trichinosis.[2] Since that time our knowledge of reservoir hosts has cumulated apace. We now realize that a considerable number of the infectious and parasitic diseases of man are contracted through the intervention of the lower animals.

Zoological Classification of Reservoirs of Human Disease. The animal reservoirs of human disease are classified in three different phyla of the animal kingdom—the Mollusca, the Arthropoda, and the Chordata.

The Mollusca, represented by the gastropods, are reservoirs of various trematode parasites, including the schistosomes responsible for one of the most important tropical diseases of man.

The arthropods are extensively incriminated in both the harborage and the transmission of disease. In the Crustacea class various species of copepods serve as connecting links in the life cycle of the broad fish tapeworm, *Diphyllobothrium latum*, and in the life cycle of the guinea worm, *Dracunculus medinensis*. Species of crayfish and stone crabs are involved as the secondary intermediate hosts of the human lung fluke, *Paragonimus westermani*. The Insecta class is notoriously involved in the transmission of various diseases of man. Mosquitoes, tsetse flies, black flies (Simulium), sand flies (Phlebotomus), mango flies (Chrysops), midges (Culicoides), fleas, lice, ticks, mites, and the true bugs are all either vectors or reservoirs of diseases that attack human beings.

Among the Chordata, there are reservoirs of human disease in the Pisces, Aves, and Mammalia classes.

Types of Disease in Animal Hosts. Animals or insects are of importance in the transmission of more than fifty human diseases. These are divided, roughly, into eight protozoal diseases, two caused by larval cestodes, seven by trematode parasites, four by nematodes, fifteen by bacteria or spirochetes, twelve by viruses, five general types by rickettsiae, and two or more by fungi; some are in an unclassifiable category. In addition to the more important diseases, there are numbers of rarer conditions occasionally associated with animal hosts. Man and the lower animals share fourteen species of pathogenic protozoa, forty-nine trematode parasites, twenty-six cestodes, thirty-nine nematodes, and two acanthocephalid parasites, any of which may cause disease.

Besides these diseases which have been proved to be transmitted to man from an animal host, there are others which are suspected of being within this category. The protozoan disease, toxoplasmosis, is a not uncommon congenital malady manifested mainly in the newborn and undoubtedly present in the mother. It is not known how the mother acquires the infection, but the fact that the etiological parasite is distributed throughout a large part of the vertebrate world, in birds as well as mammals, suggests the possibility that some animal is its source. Again, diarrhea of the newborn, usually acquired in hospitals, may be connected with a disease of cows which has recently come to the attention of scientists. It is possible that in cows the disease is manifested by mastitis, or it may have no clinical manifestations; but it is certainly transmitted to calves through milk, and it may be that human infants acquire the disease in the same manner. Another disease about which little is now known but which may possibly have an animal reservoir is the acute diarrhea now connected with influenza.

Among the fungus diseases, coccidioidal mycosis and histoplasmosis are still epidemiological problems. Coccidioides has been recovered from sandy soil, but it is hard to believe that in dry areas a fungus like this could grow without some moisture. Since it has been found among rodents in desert areas, it seems possible that some of the rodents may be reservoir hosts. The source of histoplasmosis is even more of a mystery. Large proportions of the population in middle Tennessee and around Kansas City are infected with this disease, but the etiological organism has never been recovered free in nature and it has never been found in wild animals. The discovery of several cases of histoplasmosis among dogs, however, suggests that this is another disease that may eventually be traced to an animal reservoir.

Modes of Transmission from Reservoirs to Man. The etiological agents of diseases associated with animals may invade the human body by any of several routes—through the mouth, through the skin or mucous membrane, or through the respiratory tract. The organisms also find their way from the lower animals to man in various ways. In some cases the transmission occurs by means of direct contact between man and the disease host, as when rabies is acquired from the bite of an infected dog or trichinosis from the consumption of infected pork. In other instances the mode of transmission is through the infected feces of the reservoir host. The passage of the etiological organism from animal to man may even be brought about through an intermediary vector, so that man may acquire the disease without ever having contact with the animal host, or, in these days of air transportation, without being within thousands of miles of the reservoir of disease.

In connection with the distinction between reservoir and vector, it might be mentioned that some vectors are also reservoirs. Although the louse and the tick are both vectors of rickettsial diseases, the louse cannot transmit these diseases to the next generation of louse, whereas the tick can pass them on to the next generation of tick. This is very likely due to anatomical differences between the intestinal tract of the louse and that of the tick. The tick has cells in the walls of the intestine which protrude into the celomic cavity and which may possibly be the source of infection for the ovaries and the ova. Several disease agents—those of Q fever, Russian spring and summer encephalitis, lymphocytic choriomeningitis, Western equine chorio-encephalitis, and St. Louis encephalitis —undergo this transovarial passage through the tick. Thus, for these diseases the tick is a potential reservoir. Mites may also be reservoirs of disease; it is known that tsutsugamushi disease is transovarially passed by them and possibly also St. Louis encephalitis.

Control Measures. The variety of ways in which man may be invaded by the disease organisms, coupled with the multitudinousness of the hosts and vectors involved, indicates the wide diversity of measures which are needed for the control of diseases harbored and transmitted by the lower animals. Prophylactic measures such as vaccination may be applied to man himself, or sanitary precautions may be taken with regard to man's environment. Another mode of control may be exercised on the disease host, either complete extermination, or, if this is not acceptable, as in the case of dogs, the use of prophylactic measures designed to protect the host. When there is an intermediate agent between the host and man, the extermination of the vector and quarantine procedures to bar its invasion are the usual methods of control.

Frequently, a dual or even a three-way approach is feasible —on man, on the host, and on the vector. Sometimes these varying methods of control reinforce each other. An example is the effect of human vaccination on the number of typhus-infected lice. The blood of patients who have contracted typhus after vaccination carries fewer rickettsiae than does the blood of unvaccinated patients, and lice feeding on the vaccinated patients are therefore less likely to contract the infection. Thus vaccination may prove to be an important measure for partially controlling typhus in areas where it is difficult to exterminate lice with DDT.

The fact that several techniques may be employed for the control of a single disease does not mean that the methods should always be applied simultaneously. As a matter of fact, a simultaneous attack against two agents in the spread of a disease is sometimes contraindicated. For example, although two major control measures are employed for murine typhus and for plague—the extermination of rats and the extermination of fleas—the order in which these two maneuvers are carried out is of considerable importance. If the rats are poisoned first, the fleas seek human hosts and an actual increase in the incidence of these diseases may result.

The number of participants in the spread of human diseases that are associated with the lower animals—the etiological organism, the animal host or hosts, frequently a vector or vectors, and man himself—suggests the variety of investigations necessary to bring even a single disease under control. Investigations range from wide-scale epidemiological research to detailed studies of the anatomy, physiology, and life history of a multitude of mammals, birds, fish, and insects.

The first step in the series of investigations is frequently, although not always, the linking of a human disease to a specific host or vector. Often this comes about through epidemiological manifestations; Maxcy's establishment of the relationship of an ectoparasite of the rat to typhus is an example. The investigation of St. Louis encephalitis illustrates the epidemiological method of identifying a vector. When this disease was first recognized in the outskirts of St. Louis, it was thought to be an infection spread by means of the secretions of the respiratory tract, particularly since preliminary experiments seemed to exonerate *Aëdes aegypti*. Epidemiological studies showed, however, that the cases were distributed along streams, a fact that pointed to some vector such as the mosquito. It is now known that domestic animals are hosts of the virus of St. Louis encephalitis and that the virus is probably transmitted by a mosquito.

Less frequently the connection between a disease and an animal is established deductively. The discovery that dogs are subject to histoplasmosis—a finding which suggests the possibility of an animal reservoir for this disease—came about through a casual conversation on a golf course. Perhaps one of the most dramatic discoveries of this kind, one involving both the epidemiological or inductive method of research and the deductive short-cut, was the recent identification of the mite as the vector of rickettsialpox which made its appearance in the Kew Gardens area of New York City in the summer of 1946. Rapid epidemiological investigation indicated that, inasmuch as the patients suffering from this disease were all living in one group of houses about three blocks square while persons in other houses in the neighborhood were unaffected, the disease was not being spread through milk or water or food. The prevalence of mice in the houses where the patients lived suggested the possibility that a mouse ectoparasite might be the source of the disease. The effort to identify the etiological organism by injecting the blood of patients into laboratory animals had just begun and the long process of catching mice and combing them for ectoparasites was being planned when an insect exterminator helped solve the problem. He collected some mites from the crevices of cellar walls in the neighborhood and presented them to the scientific investigators of the United States Public Health Service and the New York City Department of Health. The etiological organism was quickly recovered from these mites, then from the patients, and later from the mice. Thus the exterminator saved months of investigation which would have been needed to identify the source of "Queens disease" by epidemiological methods alone.

Status of Control. The discovery that a single species of animal is the host or vector of a disease organism does not necessarily solve the problem of control. Other animals may be implicated and—an important factor in the spread of disease from one area to another—still other animals not yet exposed to the disease may be potential hosts. Investigations to ascertain what animals are capable of being infected by a particular disease organism are therefore often indicated. In many instances, the specificity of an organism is narrow, as in the case of *Schistosoma mansoni,* which has different strains, each specific to a different kind of snail. At the other end of the scale, some organisms, such as Trichinella, may infect almost any laboratory animal.

Another line of investigation involves the effect which the disease organism has on the host or vector. An interesting finding is that both man and the insect vector suffer serious infections with the rickettsia of louse-borne typhus. The mortality rate in man is appreciable and that for mice is nearly 100 per cent, an unusual phenomenon.

As can be deduced from the foregoing discussion, there is an infinite variety of problems which must be solved before control measures can be established for many diseases with animal reservoirs. A brief survey of the over-all progress which has been made is presented here.

Among the protozoal diseases, striking results have been achieved in the control of malaria in the United States and in some other places, but malaria is still the most important tropical disease; kala-azar has had no setbacks in any area in which it exists, and oriental sore is practically uncontrolled except in certain localities in Russian Turkestan where control programs have been inaugurated. African trypanosomiasis has been the subject of attack for practically four decades with some success in certain areas; Chagas' disease is practically uncontrolled.

Little has been accomplished in the control of schistosomiasis in any area where it has been found, although efforts are being made in Egypt, Venezuela, and certain localized areas in Brazil. No attempt has been made to reduce the incidence of clonorchiasis, paragonimiasis, or other trematode infections.

Echinococcus has been distinctly limited in Iceland, and control campaigns are under way in New Zealand and Australia. Elsewhere, little progress has been made.

Filariasis and onchocerciasis have been practically untouched. In the United States there has been no reduction in the number of cases of trichinosis reported annually since figures became available.

The opportunities for the transmission of tuberculosis from lower animals to man have been reduced almost to a vanishing point in the United States by the accredited herd-testing program of the United States Bureau of Animal Industry and the various state authorities. Contagious abortion in cattle has also been materially lessened by the work of this bureau. The adoption of the United States Public Health Service standard milk ordinance for urban milk supplies and the wider application of improved methods in the production, handling, and pasteurization of milk are factors in the campaign against the transmission of brucellosis. The same may be said of septic sore throat.

Urban yellow fever is in a large measure under control, but there is always the danger that the jungle variety may escape its present barriers and find its way into *Aëdes aegypti.* The mosquito-borne encephalitides ebb and flow. Psittacosis has been restricted by the quarantine against psittacine birds. There has been practically no control of tularemia. Regulations imposed on industries handling hides and bristles, certain import regulations, and regulations covering the sterilization of shaving brushes have brought about some improvement in the control of anthrax. Rabies seems to be of concern only when it gets out of hand in a community; there has been no concerted effort to control it in the country as a whole. Plague is an ever present danger in the western states, and little progress has been made in the control of the disease in reservoir hosts.

The rickettsial diseases present a varied picture. Epidemic typhus is susceptible to control by the use of DDT and by other methods. Good progress is being made in the control of endemic typhus in the southeastern United States. Rocky Mountain spotted fever has been inhibited to some extent in certain areas by vaccination. There have been sporadic outbreaks of rickettsialpox and Q fever in the United States, and more knowledge of the distribution of these diseases is needed.

Some progress was made during the war in the control of scrub typhus in military personnel. Practically nothing has been accomplished toward the control of relapsing fever and leptospirosis.

Thus an over-all survey indicates that in places man has made satisfactory advances in controlling some of the diseases transmitted to him from lower animal reservoirs. Only slight inroads have been made against other diseases, while still others remain untouched.

As for the future, the possibilities for the control of certain of the insect-borne diseases are more promising than ever before. The development of DDT and other efficient insecticides has put into our hands weapons for more concentrated and enduring attacks upon some of the most dangerous of these conditions, and there is reason to believe that methods may soon be found that will bring others within bounds.

Specific Diseases. As has been stated in the introduction to this book, the material is based upon presentations made at the Institute on Public Health which was held at the New York Academy of Medicine under the auspices of the Academy's Committee on Public Health Relations. Obviously, in a single morning's session it would have been impossible to discuss adequately the myriad of diseases which are associated with animal and insect reservoirs. As one of the participants put it, "To discuss today's topic (in the time allowed) is somewhat similar to being given the assignment of telling in fifteen minutes the contents of the Museum of Natural History."

Detailed discussion of specific diseases was therefore limited and selective, the selection being made in accordance with the areas in which the speakers believed they had most to contribute. For this reason, the diseases described in this review are not necessarily the most important ones from a public health point of view. Nor are they discussed from all their aspects; the remarks on kala-azar, Chagas' disease, bartonelliasis, plague, and yellow fever, for example, are largely confined to the South American aspects of these diseases, even though in some cases the most important foci of infection are elsewhere.

Trichinosis. Sawitz summarized information concerning the prevalence of trichinosis in the United States through the calendar year 1936.[3] He found that there were on record a total of 4,889 cases of the disease, including those summarized by Ransom,[4] those reported to the United States Public Health Service, and those mentioned in the literature. Since the publication of the paper by Sawitz, Willard H. Wright of the United States Public Health Service has endeavored to maintain a record of cases of this disease in the United States. The two records indicate a total of 9,613 cases up to January 1, 1947.

It is unwarranted to assume from these data that approximately half of the total number of cases of trichinosis on record in this country have occurred within the last decade. As one explanation for these figures, it should be noted that the reporting of cases to the United States Public Health Service has been more general during recent years. Prior to 1930 relatively few cases were reported to this agency, and records prior to that date have been assembled largely on the basis of publications in medical journals.

Even with increased efficiency in reporting, however, it is safe to assert that the number of cases on record does not represent the actual number that have occurred. Even now the disease is not reportable in four states. A little more than 30 per cent of all reported cases have been in New York State. Even assuming that the food habits of the relatively large foreign-born population in New York are more conducive to exposure to the disease, it is scarcely reasonable to believe that this state has had nearly one third of all the cases of trichinosis within the United States during the eighty-five-year period in which the disease has been recognized as a clinical entity. It might be hypothesized instead that physicians, particularly in the city of New York, are more familiar with the disease and are more alert to the possibilities of its occurrence and that the reporting system is more efficient than in some other states.

As for the trend in morbidity from trichinosis, since nearly one half of the total cases on record have been reported within the past ten years, one might assume that there has been a marked increase in the incidence of the disease. However, reports to the United States Public Health Service indicate a rather steady morbidity rate. From 1937 through 1941 there were 2,015 cases, while from 1942 through 1946, 2,178 cases were reported, including three outbreaks totaling 731 cases.

Even though there has been no apparent decrease in the number of reported cases of the disease, there has been a substantial reduction in the case mortality rate over a period of years. Sawitz stated that the rate decreased from 15.4 per cent for the period 1842–1914 to 4.4 per cent for 1926–1936. On the basis of cases reported to the United States Public Health Service and deaths reported to the United States Bureau of the Census, Wright has calculated that the case mortality rate from 1930 through 1938 was 6.2 per cent.

Sawitz believed that this reduction was due in part to the reporting of a greater percentage of mild cases and in part to the dilution factor, which results in a decreased intake of trichina larvae. The latter is probably the more important factor in the decline. Because of the increased marketing of pork products by large packers and distributors, the meat from many hogs is employed in batches of sausage and other products so that the meat from a single trichinous hog may be mixed with that of numbers of trichina-free swine. This situation is in marked contrast to that of thirty or forty years ago, when small butchers carried out local slaughtering and retailed pork within a restricted area.

The operation of this dilution factor is well illustrated by three recent outbreaks of trichinosis in German prisoner-of-war camps in the United States. In the first of these outbreaks, which occurred in February 1942 at Fort Stanton, New Mexico, 392 of 405 prisoners developed clinical symptoms. The second involved 256 cases among prisoners in a camp in Michigan early in 1945. The third, which occurred in December 1945 and January 1946, affected 83 German prisoners treated in an Army Air Forces regional station hospital at an undisclosed location. Among the 731 clinical cases in these three outbreaks only 2 deaths occurred; these were among the 392 patients in the Fort Stanton, New Mexico, epidemic.

The fondness of Germans for raw pork was responsible for all three of these epidemics. The Fort Stanton outbreak was caused by the consumption of mettwurst which had been prepared by the personnel of the camp from pork obtained from a packing plant in El Paso, Texas. It is probable, although it was not demonstrated, that this pork came from garbage-fed hogs. The Michigan epidemic was caused by the consumption of raw, and possibly in some cases inadequately cooked, pork. The third outbreak was apparently induced by the use of raw sausage.

At Fort Stanton the infection was seemingly more severe than in the other two groups and a larger proportion of the patients showed pronounced symptoms. This can probably be accounted for by the fact that one of the four hogs used in the preparation of mettwurst on a certain date was trichinous. In the other two outbreaks the meat was purchased from contractors, and the dilution factor was much greater.

The importance of the dilution factor in the reduction of mortality is further illustrated by the report of Shookhoff, Birnkrant, and Greenberg of the largest outbreak in the history of the New York City Department of Health.[5] In this instance 84 persons became ill, none of them critically, as a result of eating various types of so-called "summer sausages" marketed by a single wholesaler.

Several methods for the control of trichinosis have been suggested, but for one reason or another none is wholly satisfactory at the present time. As Gould pointed out recently, the microscopic inspection of pork is not feasible because of the expense.[6] Nor did he look with favor on requirements for cooking garbage before its consumption by swine, on the grounds that the enforcement of such regulations would be impossible. Furthermore, he stated that the cooking of garbage would not eliminate trichinosis because a certain percentage of so-called grain-fed hogs are trichinous.

The freezing of all pork is recommended by Gould. When this question was considered some years ago by the Council on Livestock and Meat Research, however, the consensus among members of the meat industry was that this method was economically impracticable because of the high cost. Since that time methods of quick freezing have been introduced by which it would be possible to destroy trichina larvae. Quick freezing, however, results in soft, water-logged pork which has found disfavor with the customer. The cost of quick freezing is also prohibitive at present.

The main conclusions that can be drawn at this time regarding the control of trichinosis are, first, that additional research is needed on this problem and, second, that any attempts toward control will require the active cooperation of the meat packers.

Rabies. Rabies, although primarily a disease of dogs and other lower animals, is nonetheless one of the most dreaded of human diseases. No concerted movement has ever been made to control the disease in this country. Sporadic local efforts have been exercised from time to time when the disease has gained an ascendancy in a locality, but authorities are convinced that nothing permanent in the way of control can be accomplished by such haphazard attacks. Rabies is seldom confined within political boundaries, and any control procedure which will achieve results must be implemented on a national basis.

Data gathered over the years from 1938 to 1946 indicate that there has been no reduction in the number of reported cases of rabies in man and the lower animals.[7] During this period, the disease has been reported in dogs, cats, cattle, horses, mules, sheep, swine, goats, antelope, foxes, wolves, coyotes, rabbits, squirrels, ground squirrels, skunks, civet cats, raccoons, muskrats, gophers, mice, wild cats, and opossums. There have been repeated epizootics of fox rabies in some southern states[8] and recently in New York State; this occurrence of the disease among wild life makes for wider dissemination than if the infection were limited to domestic animals. Nonetheless, authorities are of the opinion that the dog is the most important reservoir host in the perpetuation of the disease.

Unfortunately, no type of human rabies vaccine produced to date provides unfailing protection, as is brought out in the report by Greenwood to the Health Section of the League of Nations.[9] This applies even more to canine rabies vaccines. It should be pointed out, however, that although until recently these products frequently lacked sufficient immunizing properties, more rigid regulations regarding production and testing have resulted in improvements. At present a single subcutaneous injection of 5 cc. of the vaccine may be expected to produce an immunity of at least a year in dogs over six months old. Vaccination campaigns together with licensing and strict quarantine for a suitable period offer a short-cut method of control when compared with previous measures based on quarantine alone.

As has been stated, if complete eradication of rabies is to be achieved, campaigns must be carried out on a national basis. Cooperating authorities should include the Bureau of Animal Industry of the Department of Agriculture, the Public Health

Service, the Fish and Wildlife Service of the Department of the Interior, and state veterinary and health authorities. Moreover, the cooperation of dog-lovers and dog-owners must be secured. With a suitably implemented and operated campaign, the disease could be eradicated from the United States within a reasonably short time.

Schistosomiasis. It has recently been estimated that 114,000,000 people are suffering from schistosomiasis.[10] It can therefore be seen that although this disease is not endemic in the continental United States, it constitutes a major public health problem in many parts of the world.

Schistosomiasis is the only one of the diseases having reservoir hosts that seeks out and attacks its definitive host. Not all of the three species of schistosomes that attack human beings, however, are equally capable of maintaining themselves in reservoir hosts. *Schistosoma haematobium* has been reported in the West African monkey (*Cercocebus fuliginosus*), but its occurrence in this host is probably so sporadic that this animal contributes little to the dissemination of the parasite. *S. mansoni* has been reported by Cameron as occurring in the West African green monkey (*Cercopithecus sabaeus*) in St. Kitts to such an extent that this animal serves to perpetuate the infection in that island.[11] Schistosomiasis is also found in certain varieties of snails.

S. japonicum is much more catholic in its selection of hosts; it has been found in a number of animals including the dog, cat, pig, carabao, horse, cow, goat, deer, rat, mole, and field mouse. The following examinations and incidences of infection were recorded by Wright and his associates in the endemic area of schistosomiasis in Yamanashi Prefecture, Japan, during the year May 1, 1944 to April 30, 1945.[12]

Not all these hosts are of equal importance in the spread of the parasite because of the fact that some pass eggs of the parasite in the stool and others do not. This variation is probably due to the different effects which the disease has on the host.

Incidence of Infection with *Schistosoma Japonicum*
among Animals in Yamanashi Prefecture, Japan
May 1, 1944—April 30, 1945

Species	*Number Examined*	*Number Positive*	*Per Cent Positive*
Dogs	353	176	49.9
Cattle	7,059	2,184	30.9
Goats	1,118	158	14.1
Horses	967	0	0.0
Mustela sp.*	10	9	90.0
"Rats" (probably including field mice, *microtus* spp.)	1,707	656	38.4
Moles	68	13	19.1

* Probably *Mustela (lutreola) itatsi.*

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For example, a mouse infected with *S. mansoni* develops an acute abscess which breaks into the lumen of the intestine and liberates the egg, whereas the rabbit, which does not pass the egg in its stool, exhibits a more granulomatous type of infection in which the egg is held in the wall of the intestine. Similar host reactions may account for the fact that the rat and the horse do not usually pass eggs of *S. japonicum,* but the dog, cat, pig, and cow do. Thus, although Magath and Mathieson found that up to 90 per cent of the rats in highly endemic areas in Leyte were naturally infected, this animal is not so important a link in the transmission of the disease as animals which eliminate the egg.[13]

As a demonstration of how investigations may indicate control measures, Wright points out that one of the original objectives of the control program which was undertaken in the Fukuyama area of Japan in 1918 was the substitution of the horse for the ox as a draft animal, for the reason that horses are more resistant to the infection.

Kala-azar. Kala-azar, long known in Mediterranean countries, in Africa, and in the Orient, was first proved to exist in the Americas in Brazil about 1934 through the routine microscopic examination of liver tissue removed post mortem by viscerotomy. Some 36,000 tissues had been examined for evidence of unsuspected yellow fever before the first liver with leishmania was noted. A re-examination revealed twelve positives, and continued examinations revealed additional cases in Pará in northern Brazil, in various other Brazilian localities, in Bolivia, and in northern Argentina.

The cases in South America tend to be isolated and sporadic, occurring in regions differing in climate, topography, flora, and fauna, with rarely more than one case to a family. In Brazil naturally infected dogs have been found, although not in large numbers, and it is possible that these animals may be almost entirely responsible for the maintenance of the infection. The situation is quite different in certain Mediterranean areas, where 18 per cent of the dogs are infected, and in China, where there are now millions of human cases in contrast to the thousands which were there prior to the war.

Studies indicate that Phlebotomi are responsible for the transmission of kala-azar. These insects are not strong fliers and generally do not fly directly into houses through open windows and doors; rather they tend to light on the outside walls and make short flights before entering houses. This fact, together with the great susceptibility of the vector to DDT, makes it seem probable that kala-azar will largely disappear as a result of the general attack on household insects with DDT, once this insecticide becomes cheap enough for popular distribution.

Chagas' Disease. American trypanosomiasis or Chagas' disease is probably the first disease which was not known to exist until its causative agent was observed in the insect vector. As a matter of fact, even the infection of monkeys in the laboratory was carried out before human cases were observed and human infection proved.

The *Schizotrypanum cruzi,* the organism that causes Chagas' disease, is widely distributed in reduviids, or assassin bugs, from the southern part of the United States to Argentina. Most mammals are susceptible; more than thirty species have been found naturally infected. In spite of this widespread distribution of the agent, the human disease is essentially a house disease that is transmitted by the Triatoma, which have become highly domesticated. The Triatoma are large, night-feeding insects that live in the cracks in the walls of mud huts or in the thatch of thatched houses. The house cat, the dog, and infected human beings are the sources of infection in succeeding generations of insects.

Chagas' disease is a serious condition and an important public health problem. It may be fatal, but its most characteristic effect is a progressive crippling of the myocardium, which occurs in about 50 per cent of the cases. It is most prevalent among the underprivileged of rural areas. The well-to-do inhabitants of these areas who live in properly plastered and ceilinged quarters acquire the disease only by accident.

The problem of control is difficult, since the infection in mammals is chronic and the vectors are all long-lived insects. Moreover, initial tests indicate that the Triatoma is not highly susceptible to DDT. Pyrethrin sprays are effective, but they must be repeated every three or four weeks.

No serious large-scale attempt has ever been made to control Chagas' disease. It still must be considered a housing problem, associated with poor economic conditions and lack of education. It is always difficult for the underprivileged to rise above their level, and it is even more difficult when they are burdened with Chagas' disease. Here, then, is a challenge to the health workers of the Americas.

Bartonelliasis. Bartonelliasis, known as Carrión's disease, causes two clinical pictures, that of acute Oroya fever and that of the chronic verruga peruana. It has been known since colonial times as a disease which attacked travelers in certain mountain valleys of Peru. Its great notoriety came during the last century when 700 workmen, who were building a bridge on a railway from Lima to Oroya, died of the disease. When it became necessary to build a new bridge, loss of life was avoided by the simple expedient of removing the laborers from the infected area each evening before the vectors became active.

A few years ago a serious outbreak of bartonelliasis occurred in a valley in Colombia not far from the frontier of Ecuador. This was considered to be an extension of the infection from the valleys of Peru and Ecuador northward. Since this region has been opened up to automotive transport during the past ten years, the easy transportation may have facilitated the introduction of infected cases and thus started the epidemic. On the other hand, it may merely have opened up the region to well trained epidemiological investigators, who discovered evidences of infection which had been present for some time. In any case, it is well to recognize the possible threat that this disease may extend beyond its present endemic area.

The Phlebotomus has been proved to be the vector of bartonelliasis, but the source of infection for the insect has not been satisfactorily explained. Because the disease occurs in areas where possible mammalian hosts are almost nonexistent, infection from plant juices has been suggested. In any event, the indicated approach to control is the extermination of the insect vector; this can readily be accomplished through the use of residual DDT spray.

Plague. Plague is one of the great epidemic diseases of all time. All are familiar with the story of its ravages in Europe during the Middle Ages and of its recession to the hinterland of the Orient during the seventeenth and eighteenth centuries. The modern invasion of the ports of the world started in the last decade of the nineteenth century; since that time the disease has become established in rodent species in various parts of the interior regions of Africa and in North and South America.

No satisfactory explanation has ever been given for the dissemination of plague in modern times, although there have been attempts to link its spread to the development of rapid transportation. This hypothesis is supported in some degree by evidence recently collected by Machiavello during investigations carried out in Peru. Since 1934, Long, of the Pan American Sanitary Bureau, has believed that plague is being imported into Peru from India at frequent intervals in shipments of jute bags. In recent years examination of two shipments revealed fleas in the bags, and the presence of *Bacillus pestis bubonicae* in the fleas was established by inoculation of guinea pigs.

The problem of long-distance transportation of infected fleas in freight can be solved by the use of DDT, either at the point of origin before materials are packed or at the point of arrival when they are unpacked. In fact, the successful development of DDT, other insecticides, and new rodenticides, such as 1080 and Antu, is causing those who had despaired of ever being able to eliminate the rat by special construction, to take new hope for achieving adequate control over plague. It has been demonstrated in Egypt, West Africa, and Peru that epidemic plague can be controlled rapidly with DDT dust without undertaking the reduction of the rat population. This short-term result can be backed up by a long-range program of rat destruction. Although 1080 is toxic for man and household pets, under controlled conditions it is efficient in the destruction of rats, and the United States Public Health Service is investigating its use for deratting ships in place of the more difficult, more dangerous, and more costly cyanide fumigation. With DDT and 1080 the future of plague control is brighter now than at any time in the past.

Yellow Fever. Yellow fever is a modern disease in that the first known description of it appeared after the discovery of America. It is not known whether the disease originated in America or Africa, and recent studies show that it might well have appeared first in either continent. To Carlos Finlay must go the credit for first—and then incessantly over many years—calling attention to the possibility that yellow fever might be an insect-borne disease. Finlay even indicated the *Aëdes aegypti* mosquito as the probable vector and furnished the stock of insects with which Walter Reed's conclusive demonstrations were carried out.

Although extensive tests with other mosquitoes were not made during Reed's investigations, the results of anti-mosquito campaigns, directed especially against the *aegypti* mosquito, left little doubt in the minds of most students of yellow fever that this mosquito was the only vector implicated in an important manner in the spread of the disease. In 1932, however, yellow fever was found in the Vale de Canaan, Brazil, in the complete absence of this domestic insect. Outbreaks of the disease occurred in 1933 in areas free of the *aegypti* mosquito, and from 1934 to 1940 there occurred a series of seven annual wave-like epidemics which spread over almost all of the forested areas of South Brazil, Paraguay, and northeastern Argentina. These epidemics, as outlined by the results of viscerotomy in human patients, were highly seasonal, being limited almost entirely to the summer months from January to June. No evidence of virus activity was observed during the winter months.

It is probable that this so-called "jungle yellow fever" is the original type of the disease and that the yellow fever which is transmitted by *Aëdes aegypti* and which was known prior to 1932 is of more recent origin, coming with the development of large cities and the adaptation of the *aegypti* mosquito to living with man. The discovery of the existence of jungle yellow fever has been followed by fifteen years of field and laboratory studies directed toward finding all the hosts and vectors—studies including not only man and the *aegypti* mosquito but all the mammals, birds, and blood-sucking arthropods and some of the flora of the tropical and subtropical jungles in South America and Africa.

Field observations during the first outbreak indicated clearly that infection was acquired away from the home, but it did not establish the place of infection. In an effort to discover a vector other than the *Aëdes aegypti,* many species of mosquitoes were captured, including the *Aëdes scapularis,* an easy transmitter of the virus of yellow fever in the laboratory. It was thought probable that this mosquito was responsible for the only family epidemic observed during the 1932 studies.

Haemagogus mosquitoes were also captured at this time, but there was no evidence to suggest that this genus might have any special importance. In 1935, however, during the second of the wave-like epidemics, which covered the southern part of the state of Goiaz and the western triangle of the state of Minas Geraes, the people themselves called attention to the Haemagogus, or "little blue mosquito" as they called it, and field investigations soon incriminated this genus as the most probable vector. So striking were these observations that laboratory studies of the ability of this mosquito to transmit yellow fever virus were repeated in spite of the fact that earlier tests had yielded unpromising results. But it was not until 1938, when the epidemic had swept down almost within sight of the yellow fever laboratory in Rio de Janeiro, that naturally infected Haemagogus mosquitoes were captured and through their bites the disease was transmitted to animals. *Aëdes leucocelaneus* was also found to be naturally infected.

An important observation regarding the Haemagogus mosquito was made in Colombia by Boshell some years ago, namely, that this mosquito is essentially arboreal. Once this discovery was made, it was possible to isolate the virus from infected mosquitoes far more frequently than had been possible previously.

It was not until the 1934 outbreak in the state of Matto Grosso that any progress was made in identifying an animal host other than man. This outbreak occurred at the headwaters of both the Rio dos Mortes of the Amazon River basin and the Rio São Lourenço of the Paraná River basin and on the divide between these two basins. The human population in this area was too scant to permit consideration of man as the only host of the virus, and positive immunity reactions from wild monkeys which were caught indicated that the infection existed among the animals of the forests. During the next ten years rather intensive studies were made of forest animals, and evidence of animal infections accumulated from thousands of immunity tests. Finally, in 1944, the presence of the virus of yellow fever in wild animals was successfully established.

There is no evidence whatsoever that vertebrates are carriers of the virus. The picture is one of a series of acute infections in individual hosts with subsequent immunity. Yellow fever is endemic in some areas because of circulating epidemics, but the disease apparently "burns out" in these areas and returns only when a nonimmune population has been restored and the virus reintroduced.

Numerous persons who have not been in close contact with the work on yellow fever have wondered why expensive studies have been continued in South America and in Africa since it became obvious that monkeys and mosquitoes were involved in the cycle of infection. The answer is that in some areas where human cases have occurred it has been difficult, if not impossible, to find monkeys, and it is even more difficult to explain the spread of the disease to certain isolated areas by either the host or the insect vector. At times, jungle yellow fever seems to move along the gallery forests, but it is also able to establish itself in small hilltop forests that are completely surrounded by plantations. Also, it has been able to invade coastal islands so far off the seashore as practically to preclude the possibility of transmission by mosquitoes or monkeys. Likewise, if only men, mosquitoes, and monkeys are involved, it is hard to explain the winter carry-over in South Brazil for a six months' period during which human cases are not to be found.

The investigation of animals other than the primates or birds as sources of yellow fever is a difficult undertaking. Immunity tests are complicated by the occurrence of nonspecific positives and by the failure of certain forms to develop clear-cut antibodies following infection. Moreover, the demonstration that a form can circulate the virus following its inoculation is not sufficient to establish its importance as a host. It must be shown that the virus circulates in quantity sufficient to cause the infection of the vector insect without difficulty. Extensive studies among the animals and birds of South America have failed to disclose other forms which are as susceptible to the yellow fever virus as are the various species of primates. Only a few of the marsupials have been found to occur in sufficient numbers and to show a response to the inoculation with the virus in keeping with the possibility that they may at times be factors in the maintenance of the yellow fever virus.

Studies in Africa have shown that jungle yellow fever exists on that continent, although the epidemiological picture is somewhat different from that observed in the Western Hemisphere. In both hemispheres the primates are subject to the disease, but the principal forest vector in Africa may well be a night-feeding mosquito, whereas the Haemagogus mosquito of the Americas is almost exclusively a day-feeder. Epidemics among human beings with a man-mosquito-man transmission in which the *aegypti* is not a factor can occur on a fairly large scale in Africa, but this pattern has not been observed in South America. A large outbreak of some 20,000 cases was reported in 1940 in the Nuba mountains at a considerable distance from the forest, and although the *aegypti* mosquito was present, other vectors were much more numerous and almost certainly more important than the *aegypti* in transmitting the disease. In the Bwamba forest area infected *Aëdes simpsoni* were found near the houses and away from the forests. The suggestion has been made that infected monkeys, raiding the native plantations, brought the virus from the forest and infected the *simpsoni* which was then able to carry on the disease among human beings.

With regard to the control of yellow fever, it can be said that we are now adequately prepared to cope with the disease. Vaccination offers an adequate protection to those inoculated and is a means of protecting native populations living in contact with the forest and persons traveling through such areas. It is also of great value in preventing the vaccinated person from carrying the infection from one area to another. No difficulty has been encountered with homologous serum hepatitis since the use of serum in the manufacture of the vaccine was abandoned. However, this control measure has the great disadvantages of all vaccines in that it requires personal contact with each person to be protected and the vaccination certificate is only as valid as the honesty of those authorized to issue it or of those who carry it.

As for urban control of yellow fever, the existence of a highly satisfactory vaccine requiring a single inoculation and giving protection within a week (instead of in a minimum of six weeks as is true with anti-larval measures) enables the health officer to face the possibility of yellow fever invasion with relative equanimity. But the best guarantee against urban outbreaks continues to be the eradication of the *Aëdes aegypti,* a procedure which has been greatly simplified with the introduction of DDT as a residual spray. In Brazil, Bolivia, and Peru it has already been demonstrated that the *aegypti* mosquito can be eradicated from the Americas, since it does not occur as a forest mosquito in this hemisphere. Through the use of a recently developed automatic disinsectization apparatus which not only delivers a measured amount of insecticide in each compartment of trains and planes, but also registers such application, cleaned areas can now be protected against reinfestation by plane- or train-borne insects. Although the complete eradication of the *Aëdes aegypti* would be impracticable in Africa, where this insect occurs as a forest mosquito, it might be eliminated from large areas of that continent.

Conclusion. Although a great deal of research is called for before all of the diseases which are carried in animal and insect reservoirs can be brought under control, promising results have already been obtained with many of them and the means are already at hand to conquer some of the most troublesome. There is every reason to hope that the continued activities of laboratory workers, veterinary scientists, epidemiologists, health officers, and practicing physicians will eventually make available control measures against the majority of this group of invaders.

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CHAPTER IV

The text of this chapter is a composite of the addresses by Drs. Richard U. Light, of Kalamazoo, Michigan, President of the American Geographical Society, and Clarence A. Mills, Professor of Experimental Medicine, University of Cincinnati College of Medicine, together with discussions by Drs. Gaylord W. Anderson, Mayo Professor and Director of the School of Public Health, University of Minnesota Medical School; James A. Doull, Chief, Office of International Relations, United States Public Health Service; Ludwig W. Eichna, Assistant Professor of Medicine, New York University College of Medicine, and Wilbur A. Sawyer, director for many years of the International Health Division of the Rockefeller Foundation and later Director of Health for UNRRA.

Climate, Geography, and Disease

The concept of geographical medicine is not essentially new. The connection between the environment in which we live and the diseases from which we suffer has been studied since the time of Hippocrates. In modern times the serious study of geographical medicine began with a three-volume work by a German writer, Finke, published in 1795.[1] Many similar systematic works appeared during the nineteenth century; of these the *Handbook of Geographical and Historical Pathology* by Hirsch is the most famous.[2] Societies were formed, such as the American Climatological Association, and great things were predicted. Interest was not sustained, however, but rather went through cycles of enthusiasm with intervening periods of neglect. All too often, in these early studies, the starting point was the thin assumption that behind every disease there must be important environmental influences, and the author assumed the task of describing the supposed influence. The weakness of such an approach is easily seen, and this weakness explains the sporadic nature of the enthusiasm for the study of geo-medicine.

As might have been expected, World War II stimulated new interest in this whole subject. Two interesting surveys of disease which have been brought forth as a result of the war are *Global Epidemiology* by Simmons and others, based on surveys made for the United States Army Medical Department, and the *Seuchen-Atlas* or *Atlas of Epidemic Diseases,* issued by the German Army Sanitary Corps.

As we see our world becoming smaller, it becomes more important than ever that thought and study be given to the relationship between geography and disease.

Indications for Study. Despite the number of forced conclusions which have been drawn concerning the connection between environment and disease, there is no doubt that a relationship exists between geographical location and the prevalence of certain diseases. It is obvious, for example, that an insect-borne infection can occur only in localities where both the insect carrier and the disease host are present. Again, the incidence of some diseases, such as goiter and fluorosis, is correlated with geological formations. Some geo-pathological relationships of this latter type have only recently come to light; it was not until 1932 that the high fluorine content of water supplies was identified as the cause of mottled tooth enamel, and the part which fluorine plays in the incidence of dental caries was first demonstrated in 1937 and 1938.

Beyond these definite correlations between geography and disease, there are other apparent relationships which have not yet been fully explained. For example, neither insect vectors nor characteristics of the soil account for the variations in the incidence of streptococcal infections in different parts of this country. Nor is there any complete explanation of the fact that the incidence of clinically recognizable diphtheria is higher in temperate climates than it is in the tropics.

These static aspects of geo-medicine—that is, aspects which are associated essentially with the presence of a specific disease in a particular locality—are not the only phenomena which are as yet unexplained. Equally challenging are the dynamic aspects pertaining to the migration of certain diseases from one place to another. Why has yellow fever not migrated from Africa to Asia? Why is malaria, which is so prevalent in the New Hebrides islands of the Pacific, not found in the neighboring islands of New Caledonia? Why has schistosomiasis not permanently migrated from Egypt to England, and why did the filariasis which developed around Charleston, South Carolina, die out apparently from natural causes?

Again, there is the problem of the time interval between appearances of certain diseases within the same area. Why did cretinism disappear from Edmonton, Alberta, only to reappear there again fifty years later? What causes recurring epidemics of certain diseases, notably influenza, when there is no increase in the exposure to the etiological organism or in the number of susceptible persons in the population?

Closely related to these questions concerning the distribution of certain diseases over specific areas and periods of time are others pertaining to the seasonal pattern which certain diseases exhibit. To take as an example the infectious diseases of the respiratory system, the incidence of diphtheria is at its highest in November, when whooping-cough is at its lowest ebb; chicken-pox reaches a peak in December and January, streptococcal infections around March, and measles in April and May; yet these diseases are all spread in the same manner.

Factors in the Distribution of Infectious Disease. In searching for explanations for these phenomena, the epidemiologist is guided by the concept that the distribution of each infectious disease is governed by three factors: the pathogenicity of the etiological agent, the opportunity for exposure to the agent, and the susceptibility of the host. It is likely that in any given instance all three of these factors are involved, although one or another may be dominant in determining the distribution of the disease. In the case of diseases which recur in epidemic form, it may be that the primary factor is an increased pathogenicity of the causative organism. The geographical distribution of the insect-borne diseases is, of course, in large part dependent upon the opportunity which a given population has for exposure to the agent. As for the susceptibility of the host, this is a most complex factor, being a composite of the many variables which determine the physiological condition of man. Three of these variables seem to be linked to geographical location. They are antitoxic immunity, nutritional status, and climate.

Antitoxic Immunity. As has been mentioned, one of the puzzling phenomena in geo-medicine concerns the fact that clinically recognizable diphtheria, so common among children in temperate climates, is not a prevalent disease in the tropics.

This cannot be ascribed to freedom from exposure, because carriers of the diphtheria bacillus inhabit tropical countries. The absence of clinical diphtheria among these children seems largely due to the antitoxic immunity which has been found to be more frequent in children of tropical cities than among those of the same ages in the large cities of the United States.

The antitoxic immunity of the population can be accepted as only a partial explanation of the problem. The next question obviously concerns the reasons why this immunity exists among children in the tropics and not among those in temperate zones. According to the predominating concept of the present day, the most important factor in the development of immunity is the prior specific infection of the individual, clinical or subclinical. It is also possible that immunity to some diseases, such as tuberculosis, may be raised by natural selection, each generation attaining a higher level of immunity than the last. In the case of diphtheria in the tropics, however, there is no evidence either to support or to deny the theory of prior infection and none to substantiate that of natural selection. In England and America, where susceptibility to diphtheria is now high, this disease was not at all prevalent one hundred years ago. Is it possible that the tropical countries are going through a similar phase and that the immunity which children in the warm latitudes now enjoy will disappear? Or is some other factor responsible for the existence of this immunity? This is a matter for further investigation.

Nutrition. It has long been recognized that the geographical selectivity of such deficiency diseases as pellagra and beriberi is due to the dietary customs of the populations affected. More recently other physiological effects have also been associated with poor nutritional habits. However, variations in the nutritional status of people living in different areas and climates may not be entirely due to improper food selection but partially to the vitamin content of supposedly adequate diets, as indicated by the studies of Clarence A. Mills.

On the theory that nutritional deficiency might play some part in the debility which affects even those who are only visiting in tropical countries, Mills and a group from Cincinnati studied the thiamine content in foods in Panama. There is a great deficit of thiamine in Panamanian meats, and the investigators who ate the native meat noted that the output of thiamine in their urine decreased steadily. After about three or four weeks this output was about one quarter of what it was when the investigators landed in Panama. As soon as they ate ham imported from the Argentine or the United States, the thiamine excretion levels were raised.

The implications of these findings cannot fail to be of significance to those interested in geo-medicine.

Climate. The geographical differential which is most likely to suggest itself, particularly in a discussion of the variations in disease between warmer and cooler countries, is climate. The possibility that climate is an etiological agent of disease has been a subject of medical speculation ever since Hippocrates wrote of "the epidemic constitutions of the atmosphere." Unfortunately, it is impossible to test under laboratory conditions the relationship which climate may have to any specific disease. As has been pointed out, the difference in the prevalence of certain diseases in particular geographical areas is very likely due to the complex interaction of many variables, none of which can be kept constant long enough for a scientifically controlled experiment of the effects of climate alone. As James A. Doull has declared, "It will never be possible under natural conditions to select two samples of mankind differing only with respect to climate."

Short-Term Effects of Heat. It is possible, however, to determine some of the physiological effects of climate. During the war Eichna[3, 4] and others investigated the reaction of normal young men (accustomed to a temperate climate) to simulated desert and jungle environments. In these studies man's ability to work in a hot external environment was examined with regard to four major aspects: his thermal balance, his circulatory state, his water balance, and his electrolyte balance.

It was found that when a man first works in the heat he is likely to become disabled because of the failure of one of these balances. He experiences a rise in rectal temperature to between 102 F. and 103 F., an increased rate of heart beat, and when he is not lying down, a fall in blood pressure to hypotensive levels with associated syncope. The subjects of the experiments who were not in good physical condition showed these effects to a more marked degree than those who were physically fit.

Nonetheless, both the fit and the relatively unfit adapted themselves to the heat in a short space of time. At the end of one week a man could complete the full five hours of work with a rectal temperature only slightly greater and a heart rate only a little above his normal level in a cool environment; also, his circulation was such that his blood pressure was sustained in both an erect and a supine position. Thereafter improvement progressed more slowly; it was often three or four weeks before maximum work efficiency was attained.

With regard to water and electrolyte balances, the losses of water and salt caused by sweating made replacement imperative. Acclimatization to the heat did not result in any decrease in the water requirement. In the case of salt, however, acclimatization is accompanied by an adaptive mechanism whereby the loss of salt through sweat is minimized. Water replacement is therefore more important and more critical than salt replacement under such conditions.

These indications of ways in which those who are exposed to unaccustomed heat can be relieved of undue stress have significance for the public health field and a particular application in industrial medicine. In so far as geographical medicine is concerned, however, they suggest no connection between external heat and a specific disease. Nor is there any indication that persons exposed to high temperatures experience persistent deleterious effects which might make them susceptible to disease.

Long-Term Effects of Heat. Eichna's investigations were made with reference to four physiological balances—thermal, circulatory, water, and electrolyte. Mills is of the opinion that the changes in metabolic activity which occur in persons exposed to external heat are much more prolonged and of more profound significance. He points out that the human body is, like the gasoline engine, a combustion machine of from 20 to 25 per cent working efficiency. This means that three or four units of waste heat must be dissipated from the body for every unit appearing as work output. So long as the loss of this large amount of waste heat is readily accomplished, man's metabolic processes are stimulated and he lives a vigorous life, mentally and physically. But with prolonged difficulty in heat loss cellular combustion subsides to a lower level and all the vital functions are depressed.

When the body is able to give off heat without difficulty—except under conditions of benumbing cold—maturity comes early, fertility is high, growth is rapid, resistance to infection is strong, and the ability to work and think is at its highest level. In tropical moist heat maturity comes later, fertility is low, offspring are of low vitality, and infectious disease meets little resistance.

While physical responses to easy loss of heat are of great importance to man, Mills believes that there are effects on the mental processes which are of even greater significance. As evidence of the mental sluggishness which results from exposure to excess heat, he points out that college students taking standard intelligence tests in the hot months of July and August achieve ratings which are 40 per cent lower than the ratings achieved in midwinter months. White rats show striking differences in ability to learn and remember when they are kept for months in stimulating coolness or depressing warmth.

Mills further believes that the effects of external heat on mental ability begin at the time the individual is conceived, and states that children of the middle latitudes in the United States who are conceived in July, August, or September are only half as likely to enter college as are those who are conceived in winter. He made a calculation of the seasonal period of conception of persons listed in *Who's Who in America* which showed a marked predominance of winter conceptions. He points out that, of the thirty-two American presidents, eleven were conceived in the first quarter of the year, ten in the second, seven in the fourth, and only four in the third.

According to Mills, not only does the lower metabolic level of people living in warm climates make them more susceptible to disease than those in temperate zones, but the variation in mental alertness also plays an important part in the geographical distribution of disease. People in the tropics do not have the mental energy to improve their conditions of life or to institute precautionary measures for the control of disease; thus parasitic and infectious diseases and malnutrition are their greatest disease problems.

The stimulating atmosphere of cooler climates, on the other hand, makes for an accelerated pace of life with its concomitant dangers of mental and physical breakdown. Arteriosclerosis and heart failure, diabetes, toxic goiter, pernicious anemia, and cancer are the diseases which Mills charges, in part at least, to the effects of climate on man in temperate zones.

Weather Changes. Since weather is a short-cycle phase of climate, many of the physiological effects which have been attributed to climate would likewise apply to weather. In addition, there are indications that correlations exist between the incidence of certain diseases and the occurrence of sudden changes in the weather. Here again scientific investigation is impeded by the absence of facilities for controlled experiments. While there are pressure chambers in laboratories for the study of the effects of high altitude, no chamber can reproduce the weather changes which take place every few days.

On the basis of such studies as have been made, Mills believes that there is a rather close relationship between changes in the weather and acute respiratory and rheumatic infections. Since cyclonic storms, which are chiefly responsible for sudden changes in the atmospheric environment, are perhaps more prevalent during the winter in the central section of North America than in any other region of the globe, Mills' conclusion would account for the high rate of acute respiratory and rheumatic infections found in the United States during the winter months. Mills also states that other conditions, such as acute appendicitis, eclampsia, and suicidal impulses, are related to the falling barometric pressure which presages an oncoming storm.

Future Research. This discussion of the relationship of geography, climate, and weather to disease has consisted largely of a series of observations of facts for which there are, at best, only partial explanations. While it is recognized that people living in certain areas of the globe suffer from diseases to which people in other regions are not subject and while some studies have indicated a few of the factors involved in these variations, there are practically no complete answers to the many questions posed. In other words, the principal conclusion that can be drawn from the observations and findings which have been made to date in the field of geo-medicine is that a great deal of scientific research is needed.

The American Geographical Society of New York undertook in 1944 to lay the groundwork for this research. The main lines of attack extended in several directions. As a beginning, plans were made for an Atlas of Diseases[5] to be prepared under the guidance of medical scientists and geographers; the first study related to "Fluorine in United States Water Supplies."[6] Intensive studies are now to be made of certain important diseases, with emphasis on the elements of time and place as well as on the environmental factors that form the ecology. The geographical factors will embrace the physical, biological, and human aspects. Cholera has been selected for the initial study under this plan, and similar investigations have been projected for the typhus group, malaria, yellow fever, goiter, plague, beriberi and pellagra, filariasis, encephalitis, and schistosomiasis.

The scope of the Society's project has also been expanded to include studies of selected geographical regions with respect to the varied pathological conditions found in them. Priority in this investigation has been assigned to the Caribbean area. Besides the two principal types of study, the Society is also planning a bibliography of medical geography, a series of maps showing the world distribution of the most important diseases with the long-range objective of revising and reissuing the maps annually, and another series of maps showing the penetration throughout the world of Western medicine.

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CHAPTER V

This chapter is based in part on presentations by Drs. Marian C. Putnam, Co-Director of the James Jackson Putnam Children's Center, Roxbury, Massachusetts, who discussed psychiatry for the child; Milton J. E. Senn, Sterling Professor of Pediatrics and Psychiatry, Yale University School of Medicine, who discussed the adolescent; and M. Ralph Kaufman, Chief Psychiatrist, Mount Sinai Hospital, New York, who discussed the adult. Other contributors were Molly R. Harrower, Ph.D., research and consulting psychologist, Vice Chairman of the Executive Committee of the International Committee for Mental Hygiene; Drs. Marion E. Kenworthy, Professor of Psychiatry, New York School of Social Work, Columbia University; Carl A. Binger, Assistant Professor of Clinical Psychiatry, Cornell University Medical College; Paul V. Lemkau, Associate Professor of Public Health Administration, The Johns Hopkins University School of Hygiene and Public Health; Daniel Blain, then Chief of Neuropsychiatry, Veterans Administration, now Medical Director of the American Psychiatric Association; and Haven Emerson, Professor of Public Health Practice, Emeritus, Columbia University.

Realities in Preventive Psychiatry

Psychiatry received so great a stimulus from the experiences of the military services in the two great world wars that there is a tendency, even among psychiatrists, to expect too much of it. It is timely, therefore, to consider the realities of the present situation, particularly the potentialities for prevention. In this chapter psychiatrists turn the light inward to evaluate the magnitude of their problem and the means which they may employ to cope with it.

At any given time there are about five persons out of every thousand in a community who are suffering from mental disorders serious enough to necessitate hospital commitment. This figure does not, however, begin to picture the actual mental health problem. It has been estimated that approximately eight million people in the United States have now or have had in the past some form of mental disease or personality disorder.

A survey made in a rural county in Tennessee in the years just preceding World War II by the state department of health with the cooperation of the Rockefeller Foundation revealed that in the population of about 25,000 there were on a selected date 1,721 persons who presented conditions of psychiatric concern. This meant a case rate for the county of 69.4 per thousand of population. An intensive scrutiny of three selected areas yielded a case rate of 123.7 per thousand. The discrepancy suggested that the actual prevalence was considerably greater than was at first suspected.[1]

A similar study of an urban area was made in the Eastern Health District of Baltimore. There it was found that eight persons per thousand of the population over fifteen years of age were suffering from definite psychoses. The incidence was six times higher in the homes of the lowest economic status than in the homes of those who were better situated. In both the rural and urban studies the rate was lower among Negroes than among whites.

These local studies were corroborated on a national scale during the period of military induction, when mental and nervous disability led all other conditions as a cause of rejection of Selective Service registrants. Of 15,000,000 men examined for military service during the war, a total of 2,480,000 were rejected because of neuropsychiatric disorders. Of the men thus lost to the armed services, 1,846,000 were rejected on examination, 382,000 were discharged medically, and 250,000 were discharged administratively, a designation used to include cases of psychopathic personality, mental deficiency, drug addiction, and homosexuality.[2] Although the majority of these rejections were for conditions that did not incapacitate the men for useful vocations in civilian life, the experience did reveal the enormous amount of mental and emotional instability in the population as a whole. And it must be remembered that this high proportion of instability occurred in a highly selected group of the population.

The wide prevalence of neurotic disability can be accounted for by the imperfect relationship between the individual and the society in which he lives. In contrast to the extraordinarily rapid technological advances of society, change in the fundamental psychological characteristics of man has been slow. Contemporary man has much the same emotions, physiological drives, ambitions, and instincts as primitive man, and yet he is exposed to an entirely different environment, one to which, in many respects, he is not adjusted. Since neurotic disability appears to be induced by the nature of our civilization itself, no one can be considered immune to it. Susceptibility to neurotic illness is universal.

This fact is not an agreeable one to face, yet its recognition has one encouraging aspect. Out of the knowledge that the "normal" is also the "susceptible" is emerging a realization that the practice of psychiatry cannot be limited to the treatment of patients who are already ill. Rather, it must be expanded to cover the much larger population of potential patients and must develop techniques and facilities for their protection. Appreciation of the ominous fact that no one is immune from mental illness must inevitably steer the efforts of medicine and its allied disciplines in the direction of preventive psychiatry.

True, these efforts, with the possible exception of child guidance work, have not yet assumed the proportion of full-fledged programs; nonetheless, seminal beginnings are apparent. Cited herein are some recent projects in applied research which, isolated as they may be at the present time, have potentialities for future expansion. Broadly speaking, these projects may be classified in two categories—those dealing with the so-called normal, and those involving persons with incipient mental disorders.

Studies of Normal Individuals. Perhaps the most encouraging signs of the reality of preventive psychiatry are the attempts which are being made to study the emotional oscillations of those in whom there is no indication of neurotic disability and to identify the points at which anxieties are likely to develop. In the main, studies of this type have thus far been limited to newborn infants. In the Rochester (Minnesota) Child Health Project, Aldrich, in a study of the crying habits of newborn babies, discovered that much of the crying in the hospital nursery occurred when nursing care was at a minimum. Within one year the crying-time of the infants was cut in half (from 113.2 minutes to 55 minutes a day). Aldrich believes that it can be decreased still further by changes in the nursing routine.

Another project of this type has been undertaken at the Cornelian Corner in Detroit. This group advocates that mother and baby room together in the obstetrical ward so that the mother will become acquainted with her baby in the hospital and will not be overwhelmed by her responsibility when she returns home. Those who are directing the Cornelian Corner are also in favor of the "self-demand" diet, that is, the infants are neither forced to a feeding schedule nor fed a prescribed amount but are allowed to eat when they are hungry and take as much or as little as they want. Pediatricians who have adopted this policy in their practice state that in as much as five years' time they have never had a feeding problem.

Thus, research into the emotional responses of the newborn has already indicated some ways in which infants can be protected from discomfort, anxiety, and frustration.

Studies of Children with Signs of Incipient Disorder. Minute direct observations of the emotional development of the very young child, comparable to the studies which Gesell has made in the more objective field of behavior, might be expected to yield equally practical results. So far as is known, research of this type is still in its infancy. Another approach to the problems of this age group has been made however—the study of the disturbed child.

Until recently little attention has been paid to this group. Few young children have come to child guidance clinics, nor are they frequent visitors at the psychiatrist's office. Little by little, this deficiency is being overcome. Pioneering steps in this direction were taken by the Commonwealth Fund in its demonstration program between 1922 and 1927. This culminated in the establishment by the Fund of the Institute for Child Guidance in New York in 1927. The institute received support from the Fund until it was disbanded in 1933, and had as its principal objective the training of psychiatrists, psychologists, and psychiatric social workers, a necessary prerequisite to the establishment of effective treatment centers. Furthermore, from 1935 until 1948 the Commonwealth Fund advanced the training of personnel for work in child guidance clinics through fellowships which were administered by the National Committee for Mental Hygiene. This program is being continued, in collaboration with the Committee, under the direction of the American Association of Psychiatric Clinics for Children with funds made available by the United States Public Health Service and some local sources. During the years since 1922 child guidance has been introduced through many school systems and through many clinics.

Although there are now about 400 clinics dealing with the mental health problems of children, either exclusively or in combination with service to adults, few deal with the very young child. An agency functioning in this area of psychiatric guidance since 1943 is the James Jackson Putnam Children's Center in Roxbury, Massachusetts, a part of the Judge Baker Guidance Center. It is staffed with psychiatrists, pediatricians, psychologists, and social workers, and has, in addition to its other facilities, a nursery school. Its function is twofold; not only does it provide for research but it also serves as a treatment agency for young children with emotional disturbances. This "early treatment," in the sense that it forestalls the development of deep-seated disease, may be classed as one of the important aspects of the practice of preventive psychiatry.

The unusual feature of this center is the use of a nursery school in the therapeutic procedure. Those who were concerned with the planning of the Center were convinced that a new kind of agency was needed, one in which there was more of a home atmosphere than is found in the existing child guidance clinics. They have therefore provided a nursery school, where psychiatrists may observe the behavior of young children in their typical daily activities, and particularly in their relations with other children and with adults. The school differs from other nursery schools in that the emphasis is not on group education, but on re-education of the emotionally disturbed child in a group setting.

A large proportion of the children who are being treated at the center spend a part or all of the day in the school, according to their individual needs. There the children's progress is followed by the psychiatrist and the social worker, who coordinate their work with that of the teacher. The pediatrician and the psychologist make periodic examinations and their findings also are discussed with those in daily contact with the children. Thus the work of all departments is brought together to form a complete method of treating the child and his family.

The need for this type of facility is demonstrated by the demand for the services of the Children's Center; the waiting-list numbers well over a hundred. Many of the children cared for at the Center developed normally for the first year or two years, began to talk, and appeared in every way bright and outgoing. Then, following some event or series of events—the arrival of a new baby in the family, separation from the mother for a short time, or illness of the child himself—a break occurred in the child's development. He became withdrawn, stopped talking, and in some cases even refused to look at people.

In practically every instance, it is found that the parents are themselves emotionally disturbed and have not been able to bring to their relationship with the child the warmth and security so necessary to his development. In the Center a suitable substitute relationship is offered to the child in the person of the teacher in the nursery school or the psychiatrist. Through this relationship the child is enabled to regain a trust in adults and, consequently, a confidence in himself.

The process of readjustment is not necessarily a long one. Sometimes a child who has been almost completely withdrawn from people for one or two years will, after only a few visits to the Center, where the atmosphere is sympathetic to both mother and child, demand to return to his old relationship. Often this demand is not expressed in words but in action; the child will get his coat and hat or will run out to the automobile and clamor to go home. This desire to return to the normal environment indicates the successful culmination of a case which, had it been allowed to progress, might have become one of deep-rooted mental disorder.

Detection of Those with Incipient Disorders. Requisite to the success of the second aspect of preventive psychiatric practice—the institution of early therapy for those with incipient disorders—is the development of techniques for detecting emotional disturbances which can be applied to large numbers of people simultaneously. The fact that the entire population is susceptible to neurotic disability precludes any hope that the problem can be handled by individual examination; new screening methods and the broader approach of educational measures will be needed.

In recent years considerable progress has been made in modifying various tests originally constructed for use on an individual basis so that they can be applied to large groups. In 1944 two psychiatrists, Washburne and Jacobs, with a clinical psychologist, Harrower, undertook an experiment on the entire summer-school population of the University of Wisconsin. The clinical psychologist gave screening tests to large groups of students in an attempt to discover those who needed more careful investigation, and the students thus selected were examined by the psychiatrists. Of the 300 students who took one particular screening test, 79 were referred for psychiatric evaluation, which revealed that 22 of them had serious emotional disturbances. These 22 received systematic treatment throughout the six weeks' summer-school period, and only one of them eventually broke down and had to be sent home. No other student throughout the summer was referred to the psychiatric department. Inasmuch as this was the first summer session in which the psychiatric department had not had several cases to deal with, it can be presumed that in an appreciable number the occurrence of serious disease was forestalled by the early detection of and prompt attention to emotional disorders.

Although testing programs of this kind have not yet been widely adopted as a routine measure, there are other isolated instances of their use. In the public schools of Madison, Wisconsin, Waller applied screening tests which were followed by conferences between the psychologists and the parents and teachers of each child who had thus been selected. Munroe at Sarah Lawrence College has made a detailed evaluation of every student and can see to it that anyone who needs attention is referred to a psychiatrist.

It is not always necessary that diagnostic tests be labeled with their objective. For example, a psychologist in a large industrial concern has introduced into the tests which are given routinely some which bring to light emotional difficulties and has made arrangements to route to the health department persons who are marked as needing help. Again, tests given at Cooper Union for the primary purpose of investigating the difference between creative ability and technical proficiency can also be used to identify persons who should have further psychiatric study.

Preventive Psychiatry. Successful as these testing projects have proved to be, they cannot be regarded as the complete solution to the problem of detecting all those in need of psychiatric guidance. In the first place, despite their expansion from individual to group tests, they can be applied to only a small segment of the population; not for many years, if ever, will it be possible to examine all susceptibles periodically. Secondly, by their very nature tests cannot be directed to the point where preventive measures can most effectively be applied—the young child.

The importance of treating the early manifestations of emotional disorder in very young children has been emphasized. But those who focus their attention on infant care soon come to the realization that efforts at prevention and correction of difficulties must be directed largely toward parents. For it must be remembered that in mental disorder, as in somatic disease, the parent is usually the first diagnostician, the one who decides whether the child is sick enough for the doctor to be called in. As one of the determining factors in the campaign for early treatment, the parent must be encouraged to seek psychiatric assistance as soon as the child shows any signs of emotional disorder. This will involve an educational program of no small extent. Because of the stigma which still clings to the idea of emotional illness, mothers refuse to acknowledge that their children are in need of psychiatric attention. Yet until they realize that it is no more extraordinary for a child to develop quirks in his emotional life than it is for his teeth to come in crooked, efforts toward the early detection of psychiatric disorders will not be completely successful.

The problem of prevention is inextricably interwoven with the problem of treatment, and if prevention begins in childhood, the process must begin with the parent. In the case of practically every child who comes to the James Jackson Putnam Children's Center, it is found that the parent is also emotionally disturbed, and treatment of the child involves work with the parent as well. For neurotic disability is transmissible, and, as is the case with other communicable diseases, measures aimed at its prevention must include the treatment of sources of infection.

It should not be presumed from the foregoing discussion that the only, or even the chief, goal of preventive psychiatry is the eradication of specific behavior disorders. A far more important and positive approach lies in attempts to enrich the personality of human beings so that they will get more satisfaction from living and develop a greater resistance to the stresses and strains of everyday existence.

Here again it is upon the parent that efforts must be concentrated. For it is the mothers and fathers who are largely responsible for the early life experiences which are so important in shaping children's personalities. For this reason, it is necessary for all parents to have a working knowledge of the basic laws of mental hygiene and to acquire an understanding of the natural history of the development of the emotions, behavior, and mental health of young children. Educational programs are indicated similar to those in which mothers are taught about proper nutritional and sleeping habits and other matters pertaining to the physiological development of the child. The education of prospective parents is also a logical approach, and in communities where adequate programs have been installed, they have proved to be productive.

Guidance of Adolescents. Going back even farther into the pre-parent stage, Senn emphasizes that the education and guidance of the adolescent offer real and practical opportunities for the practice of preventive psychiatry. Not only is the adolescent particularly receptive to learning about parenthood, but because of the profound adjustment he is undergoing in the transition from childhood to adulthood, he should receive help for his own sake. On the one hand, he is beset by perplexities concerning his bodily development, personal relationships, ethical values, and vocational choice and by anxieties about his future; on the other, he is undergoing a process of disassociation from his old dependencies, and while craving parental assistance, often cannot accept it when it is offered.

The rearrangement of childhood ties of dependency upon parents and the successful acquisition of new relationships outside the family is considered the essence of healthy personality development at this age period. The person to whom the adolescent attaches himself assumes an important role in the mental hygiene program. Since this person usually is the teacher who can be the source of psychological help to the adolescent, any large-scale program in preventive psychiatry must include the teacher. This, of course, carries implications concerning the selection of teachers. Emphasis should be placed upon their interest in children and upon their own emotional health as well as upon their intellectual qualifications. It also suggests the need for the revision of curricula in the schools in which teachers are trained.

Another of the school's responsibilities, although often a neglected one, is sex education. The adolescent is eager for information about male and female physiology and the process of reproduction. Information which is acquired in these matters at home, at school, and from contemporaries helps the student understand the role of men and women in society and helps him in his adaptation to his own sex. The school should supplement sex knowledge given by parents, and books that answer the questions of young people should be available in school libraries.

Sex education should be given not only in the form of discussions or lectures but more especially through individual guidance and through the educative processes themselves. Experience has shown that when an adolescent has contact with infants and children in a nursery school setting within the framework of a high school or college he learns about himself as well as the children. Participation in the physical management of children gives him assurance and self-confidence in later years when he is approaching parenthood. Contrariwise, adolescents and young adults who have had no opportunity to observe and handle young children and to demonstrate to themselves their abilities as potential parents approach the responsibilities of parenthood surrounded by apprehension and feelings of inferiority. Through sex education and the provision of opportunities for child care the school can be of considerable service not only to the adolescent of today but to the generations yet to come.

Medical Participation. Like the parent and the educator, the physician in general practice is in a key position in the program of preventive psychiatry. He, perhaps more than anyone else, is in a position to screen for more expert care patients with incipient psychiatric disorders and to handle marginal difficulties. From 50 to 75 per cent of his patients, according to surveys, have personality disorders which are intimately connected with their symptoms.

To refer all these patients to a psychiatrist would be patently impossible. The practicing psychiatrists of the country are already overwhelmed with the care of the thousands of acutely ill patients who are jammed into mental disease hospitals. The

American Psychiatric Association, which includes in its membership the majority of psychiatrists in the country, has slightly more than 5,000 members, and it has been estimated that from 10,000 to 14,000 more are needed to cope with the many aspects of mental illness. In the face of this dearth of specially trained personnel, much of the responsibility for caring for the moderately ill will have to be assumed by the internist, the pediatrician, and the physician in general practice. To help carry the load, large numbers of clinical psychologists, psychiatric nurses, and psychiatric social workers are urgently needed.

In order to prepare physicians for their responsibilities in the treatment of emotional ills, medical schools will have to revamp their curricula to include the psychiatric approach. This does not mean merely an increase in hours devoted to psychiatry, although Menninger recently stated that the average medical curriculum allots only 1 to 5 per cent of the time schedule to psychiatry, but rather that a reintegration of the psychological with the somatic is needed. A medical curriculum that would graduate physicians able and willing to practice comprehensive medicine would be one of the most valuable contributions that could be made in the field of preventive psychiatry. Moreover, the educational process should continue after the student has been graduated from medical school. Every general hospital, regardless of its size, should have a psychiatric department, not only for the diagnosis, evaluation, and treatment of frank psychiatric problems but also to serve as a focus within the hospital for the education of all staff members and personnel in the recognition of the importance of psychological factors in all illness.

A similar reform is indicated in schools of public health. The fact that the problem of the mentally ill constitutes the largest single problem in morbidity makes it one of great public health concern. Yet there is only one school of public health in the country with a full-time research and teaching program in mental hygiene. The total budget of all schools of public health for research and teaching in the field of mental hygiene is about fifty thousand dollars.

Conclusion. To undertake successfully the prevention of any disease or disorder there are two requisites—knowledge and organization. On the one hand, there must be available information concerning the cause of the illness, understanding of the means by which it is transmitted, and some knowledge concerning those who are susceptible to it. Equally important, there must be an organized program by which this knowledge may be put to use and prophylactic techniques applied at the points of maximum effectiveness.

Measured against these standards, preventive psychiatry is in its seminal stages only. Despite the existence of considerable evidence and strong intimations, the cause of neurotic disability is not known specifically. There are likewise gaps in our knowledge concerning its means of transmission.

Even greater than these deficiencies in knowledge is the lack of organization for the prevention of this type of disorder. In comparison with the needs, facilities are few and trained personnel is scarce. This in the face of a disorder to which the entire population is susceptible!

Yet the prospect is not wholly discouraging. Facilities can now be provided with federal funds made available under the Mental Health Act. Provision is also made in this law for the training of personnel. But most encouraging of all is the success with which the pioneer programs have met—success not only in terms of the knowledge which has been acquired and the techniques which have been developed, but, equally important, in the organizational patterns and teamwork methods which have emerged. Small and isolated as many of these projects are, they have satisfied all criteria as to the successful results and applicability which are required of large-scale programs. They are proving that preventive psychiatry is not a vague dream but a reality at last.

Psychiatry today is in the curious position of having acquired, through a tremendous popularization, a somewhat magical aura, while it is still suffering from a carry-over of the medieval attitudes which placed an everlasting stigma on the psychiatric patient. In order to achieve preventive psychiatry it is necessary not to popularize psychological concepts, psychoanalysis, or illogical and spectacular cures, of which there are none. Preventive psychiatry is a matter, not of slogans, but of a fundamental change in attitude toward the problem; this can come only when the medical profession itself is able to adopt a practical and objectively sympathetic attitude toward psychiatric patients. It is necessary to arouse a fundamental interest which should spread to the medical schools and to the general public, who, if properly informed, would demand adequate facilities for the treatment of the mentally ill.

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CHAPTER VI

This chapter is based on contributions by Drs. Charles L. Williams, Assistant Surgeon General, United States Public Health Service; James E. Perkins, then Deputy Commissioner, New York State Department of Health, and now Managing Director of the National Tuberculosis Association; Martha M. Eliot, former Associate Chief, United States Children's Bureau, Federal Security Agency, Washington, D.C.; and Samuel Frant, Deputy Commissioner, New York City Department of Health. Additional material was adapted from discussions from the floor by Drs. Haven Emerson, George Baehr, Victor G. Heiser, and Harry S. Mustard, Director of the School of Public Health of the Faculty of Medicine, Columbia University, and Commissioner of Health of New York City.

Trends in State and Local Health Service

It is not difficult for the historian to select from past events those which form themselves into a continuing pattern and to ignore those which in the light of subsequent circumstances are revealed as merely isolated phenomena. The identification of trends during the period of their development is not so easy. He who attempts to identify trends during his own lifetime is likely to be disillusioned. Some of the would-be trends fade away in the mists of time; others may be diverted or even reversed by some unforeseen turn in the affairs of men.

Until comparatively recent times health services in the United States have developed in fragmentary fashion and along disparate paths. As public health has evolved into a science, however, certain methods of furthering the application of its principles have gained sufficient acceptance to make it safe to assume that they indicate trends. Many of the definitely discernible trends in state and local health services spring from the intensification of the public health activities of the federal government incidental to the development of statism and a national concern in preventive and curative medicine. Other trends are the products of policies originating within state and local jurisdictions or of the efforts of voluntary agencies interested in special fields of health work.

Although federal grants to states for public health purposes were proposed as long ago as 1879, appropriations were first made for demonstrations in rural sanitation in 1916 and for maternity and infant care with the enactment of the Sheppard-Towner Act in 1921. The present system of huge grants-in-aid was instituted with the passage of the Social Security Act in 1935. For 1937, the first year the program was in operation, the Public Health Service received $8,000,000 and the Children's Bureau $6,473,476.67 for allocation to states. Ten years later funds distributed to the states by the Public Health Service for general health purposes, venereal disease, and tuberculosis control amounted to $29,633,877.71; the Children's Bureau distributed $18,500,000. For the Emergency Maternity and Infant Care program administered by the Children's Bureau there was an additional appropriation of $16,664,000, making the total amount appropriated for grants-in-aid for that year $64,797,877.71. In the period from 1935 to 1947 the Public Health Service funds have expanded not only in amount but in the scope of their application.

Mustard in his monograph, *Government in Public Health,* one of the series of studies prepared under the auspices of the Committee on Medicine and the Changing Order of the New York Academy of Medicine, points out that the years in which the trend toward federal participation in health work has grown were not entirely normal ones; they included a depression, a new venture in social security legislation, and a war. He comments that it seems reasonable to believe that at least some of the increased and intensified federal health activities arose because of unusual problems and responsibilities. Although other pressures may force the continuance of the trend, Mustard believes that the present scale of federal grants-in-aid cannot be considered as either "assured or inescapable."

Four important trends are currently being stimulated by federal appropriations: the development of programs for the control of specific diseases or for the benefit of certain groups, the expansion in the number of local health departments, training of personnel, and the assumption by health departments of certain phases of medical care.

Programs for Specific Purposes. Since Congress, responding to the expressed wishes of the people, is more inclined to appropriate money for specific diseases than for general health purposes, a trend has developed in the states to conduct programs for the control of individual diseases or groups of diseases. Thus the pattern of federal grants will forecast certain health activities throughout the country. Another trend influenced by federal appropriations is the centering of health programs around particular population groups; the outstanding example of this trend is the growth of programs for child health and child welfare. State health officers have in the past resisted these developments and in a few instances states have refused to accept grants-in-aid.

Although federal aid has been made available at various times in the past to finance cooperative studies on specific diseases, particularly trachoma, pellagra, and malaria, the first real attempt to single out a group of diseases for public health activities by the United States Public Health Service in cooperation with the states appeared with the establishment of the Venereal Disease Division under the Venereal Disease Act of 1918. This first effort collapsed of inanition within a few years, but reappeared in a new form in 1938, when the present division was formed under a new law. Since then the government has established the Tuberculosis Control Division, the Industrial Hygiene Division, and the National Cancer Institute, each entrusted with funds for allocation to the states. In 1946 the National Mental Health Act was passed, authorizing a program of mental health activities; more recently legislation has been passed to set up institutes for the study of heart disease and dental health. Furthermore, there are indications of the imminent establishment of units for the control of other diseases.

A few examples will make clear the way in which public health programs in the states are stimulated by federal grants-in-aid. In 1944 the Tuberculosis Control Division was established by the United States Public Health Service and immediately began a vigorous campaign to assist states in developing their programs to control tuberculosis. In that year only twenty-one states had full-time tuberculosis control officers; at the end of the fiscal year 1947 there were forty-five such officers in the states and territories. In 1947 there were approximately

570 x-ray units in the country employed in case-finding and about 3,500 full-time workers engaged in tuberculosis control. Many states have conducted surveys to determine needs for additional hospital beds for the tuberculous, and funds have been appropriated for construction.

The Venereal Disease Control Act of 1938 helped materially in establishing or strengthening programs in every state and in every city with a population of 500,000 and over. The new and simplified methods of treatment for the venereal diseases have given health departments potent weapons with which to bring these diseases under control and have redirected emphasis from case-holding to case-finding.

The passage of the National Mental Health Act in 1946 authorized the Public Health Service to make grants-in-aid to states for expansion and improvement of mental health services, although funds were not immediately appropriated to carry out the law. At the end of the fiscal year 1947 all but four states and territories had designated an official agency as the mental health authority and all had received instruction in the administrative procedures necessary to initiate the program in each state. The goal in this endeavor is the establishment in each state of one outpatient mental health clinic for each 100,000 inhabitants; rural areas are to be served by traveling clinics. Surveys have been made in many states to ascertain the number and distribution of qualified psychiatrists, training facilities, research facilities and programs, community outpatient clinics, institutions, state commitment laws and procedures relating to the care and treatment of the mentally ill, and possibilities for establishing or expanding preventive mental health activities.

Federal assistance for the establishment of industrial hygiene activities was accelerated by the mushroom growth of industries during World War II, and it has been continued. By 1947 all except three states were conducting organized services in this field. In 1947 grants-in-aid were specifically earmarked for this purpose for the first time; new consultants were provided to give the states direct assistance, some in the establishment of industrial hygiene units, some for specific problems of operation.

Dental health is another specialized field in which federal funds have tended to shape public health programs. Aided by dentists commissioned in the United States Public Health Service, nearly every state had organized a dental health program by 1947, although some of them, because of the difficulty of procuring personnel, have not had full-time dental directors. Connecticut, Massachusetts, Wyoming, and South Dakota have recently expanded their dental health activities. In Connecticut a law has been passed authorizing the state health department to furnish dental services for children in areas where such service is difficult to obtain. The Massachusetts law directs the state department of public health to study the problem of dental caries, particularly the effectiveness of fluorine in prevention. South Dakota and Wyoming have set up dental divisions within their state boards of health to develop and promote activities for the protection and improvement of dental health. The newest phase of federal concern with the improvement of oral health was the passage by the Eightieth Congress of a bill establishing dental research facilities in the Public Health Service with an initial appropriation of $750,000.

Running parallel with the evolution of programs concerned with specific diseases has been the tendency to single out certain groups of the population for concentrated attention; this type of program is implemented through grants to states. The cardinal example is the work of the Children's Bureau in the course of the past three decades; indeed, the concept of a health program directed toward a particular group was introduced with the enactment of the Sheppard-Towner Act in 1921 "for the promotion of the welfare of maternity and infancy." Recently a movement to bestow corresponding attention on the aging population through separate departments of geriatrics in health agencies has gained considerable momentum.

Although the Sheppard-Towner program was terminated in

1929, it laid the foundation for the broader system of grants-in-aid which arrived with Title V of the Social Security Act in 1935. Under the new authorization, grants have been allocated to states for maternal and child health services and for the care of crippled children. Spurred by the funds thus made available, every state has instituted an active program in these two fields. They have met opposition from the medical profession, from lawmakers, and even from health officers, but it is generally conceded that the net result has been a quickening of interest in the problems of women and children and a stout maintenance of the principle of aiding an individual group of the population through the mechanism of grants to states. The pattern of federal aid extended even farther during the war when the Children's Bureau administered what was popularly known as EMIC, the Emergency Maternity and Infant Care program for maternity care of the wives of certain classes of service men. The implications of this wartime program, now liquidated, will be discussed later.

Development of Local Health Units. In 1915 only fifteen counties in the United States were served by local public health units under full-time health officers. During the next twenty years more than 800 counties developed some form of health service in either single county or multiple county units, but the number fluctuated so that at the end of 1934, just before the passage of the Social Security Act, the service was still in operation in only 541 counties. One of the primary objectives of the Social Security Act was to give impetus to the establishment of local health services throughout the country. By June 30, 1942, 1,828 of the 3,070 counties in the United States were served by health units under the direction of a full-time medical officer.[1] Much of this gain was lost during the war, and although in the past two years more and more states have appropriated money in an attempt to fill the gaps that now exist, at the end of 1946 only 1,322 counties, accounting for about 65 per cent of the population, had the benefit of organized health service. Commenting on the halting progress in the provision of the basic element in a health service, Mustard declared that as long as there remain vast areas and millions of people without elementary health care, "it seems impossible to escape the conclusion that the next urgent step in public health administration in the United States is to provide effective health service under government auspices in every community of the nation."[2]

Not all the stimulus for the establishment of local health units originates in the distribution of federal funds, however. New York state, where a dual system of part-time local health service plus a district service provided directly by the state has grown up through the past century, recently adopted legislation designed to accelerate the formation of county health units. Although provision was made in 1921 for the organization of health services on a county basis, only six county health units were established from that time until a new law was passed in 1946 which liberalized the aid from the state. A county health department may now partake of state funds to the extent of 75 per cent for the first $100,000 of approved expenditures and 50 per cent for expenditures beyond $100,000. Since the enactment of this legislation a number of new county health departments have been established, and many other counties have manifested interest in the possibility of setting up units.

Since the end of the war several other states have provided increased allotments for the support of full-time local health services. During the legislative sessions of 1945 Florida, Michigan, Ohio, Kentucky, Illinois, and Oklahoma appropriated funds to aid local health units. In 1946 Florida organized district units to cover the twenty-five counties that lacked full-time services.

Training of Personnel. Since shortages of personnel seriously hamper efforts toward expansion of health departments, health agencies have in recent years directed a part of their energies toward increasing the number of trained public health workers. This trend has been fostered by the application of a part of the grants-in-aid allowed under the Social Security Act to training programs; funds distributed by both the Public Health Service under Title VI and the Children's Bureau under Title V have been used for this purpose. Funds for training were also authorized in the Federal Venereal Disease Control Act of 1938, and philanthropic foundations have contributed to some of the programs. During the period 1936–1944 grants administered by the Public Health Service alone had contributed to the training of more than 7,500 health department staff workers. In 1936, 23.2 per cent of the Title VI funds were expended for training, but by 1940 the percentage decreased to 9.1 and by 1944 to 3.3.[3] The highest proportion of the venereal disease control funds used for training at any time was 4.2 per cent in 1940; in 1944 the figure dropped to 1.0 per cent. As the expenditure of federal funds for training has been decreasing, except in the case of the Children's Bureau, there has been a tendency for the contributions of state and local governments to increase.

A particularly well rounded program of inservice training for health department personnel has been carried on in Mississippi for almost ten years through funds supplied by the various federal government sources and by the Commonwealth Fund and the Rockefeller Foundation.[4] One county health department in the state was designated as a training center where practical courses are held for health officers, nurses, sanitation supervisors, and clerical workers. Conferences of various types for special kinds of workers, staff meetings, courses for health educators and venereal disease investigators, institutes for workers on a malarial control project, and numerous postgraduate courses for physicians have formed a part of this active program.

A different type of plan, one conducted by a rural health department for its own staff, reflects equally well the trend toward inservice training for public health workers.[5] Forced by a scarcity of workers to hire utterly untrained men for its staff, the health department of San Luis Obispo County, California, trained them as they worked. The results were so successful that a plan of continuous education was adopted not only for the orientation of new workers but for the stimulation of the staff already in action. Through monthly staff meetings the entire program of the department was reviewed, and valuable suggestions for the improvement of service resulted. Gradually interest developed to the point that a planned study period was included in the staff meetings, with resulting benefits in program planning, intra-agency relationships, and understanding, as well as encouragement to the staff to seek further knowledge through other channels. The department regards this use of the staff meeting as an important adjunct to refresher courses, field visits, institutes, field demonstration experience, and schooling on stipends. The New York State Department of Health, one of the strongest in the country, has for many years served as a training ground for health officers, as witnessed by the number of its former staff members who have gone out to assume important posts in local, national, and international health agencies. The New York City Department of Health has a formal training program financed with funds made available by the United States Public Health Service.

A factor that may influence the personnel shortage within the next few years is the expansion of existing medical schools and the establishment of new ones. Since the end of the war several states have made provision for the education of larger numbers of physicians; among them are Alabama, California, Massachusetts, Mississippi, North Carolina, North Dakota, and Washington. The Mental Health Act may also assist in solving the problem in its own field by providing training for psychiatrists. These men and women will be needed during the development of mental hygiene programs by public health authorities.

Trends in State Health Administration. The present-day trends thus far enumerated represent activities developing in the states chiefly through a financial relationship to the federal government. There are internal problems, however, that are peculiar to state health administration; these must be worked out within state boundaries. In most states the health activities are scattered through half a dozen or more agencies. In a study published in 1941 the estimate was made that only 18 per cent of the funds spent for health protection by all state agencies was expended by the health departments and that only 60 per cent of the 18,737 persons employed in health work were engaged by the health departments. Plans for the integration and unification of the various scattered units are the increasing concern of modern administrative experts.

New York State recently attacked this problem of multiple agencies sharing in health activities in several ways. In 1946 the governor created an Interdepartmental Health Council consisting of the state commissioners of health, mental hygiene, education, and social welfare. The purpose of the council is to coordinate plans within the state administration as well as the health services that eventually reach the individual citizen. A typical matter for consideration by the joint agency is the administration of school health services. Similarly, a Committee on Community Health Services has been formed within the state health department to advise counties on the development of local health departments, general hospitals, and laboratory services. Through the work of this committee, recommendations for well rounded programs have been evolved for a large number of counties interested in establishing health departments.

In New York State integration of health services at the state level is being further encouraged by a smoother cooperation with voluntary agencies, particularly the state medical society. The state health department has adopted a policy of consulting with the society's committee on public health and education on every program involving the medical profession or the practice of medicine. In the same way close relations are maintained with the State Charities Aid Association, the Hospital Association of New York State, and the New York State Association of Public Health Laboratories. James E. Perkins, former deputy state commissioner of health, has reported that frank discussion with these groups has resulted in action helpful to all concerned: "Our procedures and programs are being developed in a friendly, cooperative spirit of constructive criticism with those professional and lay people and agencies most involved."

Trends for the future will probably not follow the same pattern in every state, since local and regional conditions will inevitably modify the operations of state health departments. Until local health departments have gained sufficient strength to carry on effectively, it will be necessary for the state to provide some supervision over local activities, demonstrate new methods and practices, and subsidize at least some local services. The ultimate destiny of the state health department, however, may be that of counselor and guide, its direct functions being limited to tasks that concern the state as a whole—the collection and publication of vital statistics, the maintenance of biological and diagnostic laboratories, in some instances the operation of hospitals for communicable diseases and research institutes, and revisions of the state sanitary code.

Emphasis on the Control of Chronic Diseases. The application of public health procedures is responsible for one salient trend currently making itself manifest in health department activities, namely, the increasing emphasis on the control of chronic diseases. This movement is now in its incipiency, but many believe that within a generation or two it may considerably influence the operations of health agencies.

There are two reasons for this trend. First is the fact that although much remains to be done in the control of communicable diseases, notably the respiratory infections, many of our worst enemies among the communicable diseases, the real killers, the widespread pestilences, have been or are being brought under control. To a material degree this is the direct result of efforts of public health workers, though changes in our way of life which were not adopted primarily for health reasons are also partly responsible. The second reason for the shifting emphasis, a corollary of the first, is the changing balance of age groups in the population; this shift accounts for a larger proportion of persons of middle and old age.

As an illustration of the diseases which are now almost completely controlled, none can serve better than the so-called quarantinable diseases which have been world-wide menaces and which have virtually disappeared here. The number of public water supply systems in the United States has grown from 3,200 in 1900 to about 14,500 today; whereas only 35 per cent of the total urban population was served by public sewage systems in 1900, the percentage has now risen to 87. The purification of water supplies and the operation of sewage systems have practically eliminated the danger of transmitting cholera in cities. Epidemic or louse-borne typhus fever is of little concern to us for the simple reason that the people of this country have become bathtub-conscious. The development of a potent vaccine and the introduction of new insecticides which may be applied over wide areas have in large part allayed worry concerning the introduction of yellow fever. The practically universal use of vaccination has reduced the threat of smallpox to almost nothing. Rat control on ships has almost entirely eliminated the overseas transmission of plague, while better construction of homes, higher standards of personal cleanliness, and the new insecticides, by protecting the population from rat fleas, serve as additional barriers against this disease.

Nor are cholera, typhus, yellow fever, smallpox, and plague the only communicable diseases over which control has been established or promised. In 1900 typhoid fever and diphtheria claimed thousands of lives in this country; today they approach the vanishing point. Before World War II malaria cut productive efficiency in the southern states by one third; today this disease accounts for 4 deaths and 33 cases per 100,000 population annually in the United States. In 1930 about 90 per cent of the country's tuberculosis patients suffered permanent disability or died young; nowadays 70 per cent of the infected persons discovered by large-scale x-ray programs are in the early remediable stages of the disease. If smallpox were as prevalent now as it was in 1900, it would cause 5,500 fatalities annually; actually, it has become one of the rare diseases. On the occasions when smallpox does appear in a community it can be quickly stamped out, as was done in New York in 1947 by an intensive campaign of vaccination.

The changing pattern of the mortality curves, brought about by advances in control over the communicable diseases and the great reduction in infant deaths, has thrown into prominence the diseases that strike the aging. There are as yet far too few programs to deal with the degenerative diseases and long-term illnesses in general. There is, however, a distinct trend in that direction.

Cancer, the second leading cause of death in persons between the ages of 35 and 55, has received wide public attention, both from individuals and from federal and state health agencies. In 1946 federal funds were earmarked for cancer control for the first time, and it is expected that state efforts toward the control of cancer will increase materially. Many states, however, did not wait for federal grants to launch their programs. Arkansas, Mississippi, North Carolina, and Pennsylvania are among those which have recently added cancer control to the functions of their health departments. In 1945 Pennsylvania appropriated $100,000 for cancer research and a survey of the need for diagnostic and therapeutic facilities.

Congress has displayed growing interest in other diseases of later life. At the moment, diseases of the heart and arteries arouse the greatest concern, an interest well justified by the statistics on the causes of death. Taken together, diseases of the circulatory system account for more than three times as many deaths as does cancer. This fact cannot be cast aside by the familiar remark that we must all die some time and the stopping of the heart is always the essential cause. With an increasingly large part of the population developing a major interest in pushing back the death line, Congress took a step toward a means of controlling the cardiovascular and other degenerative diseases with the enactment in June 1948 of a law empowering the United States Public Health Service to establish a National Heart Institute comparable to the National Cancer Institute.

Administration of Medical Care Programs. With the heightened emphasis on diseases which are not truly preventable, health departments are beginning to extend their activities beyond the borders of environmental control and immunization into the realms of clinical concern. The adoption of public programs designed to provide treatment for disease and to prevent prolonged or permanent disability foreshadows a new trend in the functions of state and local health departments—the administration of programs of medical care.

The origins of this trend may perhaps be found in the areas of tuberculosis prevention and child care. Both movements had their beginnings more than five decades ago when tuberculosis clinics and "baby milk stations" sprang up under voluntary auspices. Gradually the tuberculosis clinics were established under the auspices of the health department. The milk stations followed the same pattern. Their functions expanded beyond providing milk for poor families and furnishing nursing care to sick infants; today they are known as child health conferences or clinics. The child health conference has been described by Martha M. Eliot, former Associate Chief of the United States Children's Bureau, as "a place where local doctor and public health nurse, under the auspices of the local health agency, confer with mothers and fathers and offer through individual or group advice a positive program for the improvement of the physical and mental health of the baby or preschool child. When it is well organized, this child health clinic provides special instruction to families on problems of food and nutrition for children through the consulting service of a nutritionist. It provides dental hygiene instruction and dental care for preschool children. At such a conference arrangements can be made for special diagnostic services when behavior problems get beyond the capacity of the pediatrician or general practitioner or nurse, or when the social and economic needs of the family call for other skills or other types of help than those which can be provided by the child health staff. The channels of contact between this child health center and the home are kept open by the public health nurse or by other visitors for whom she may arrange."

Increasingly throughout the country the local departments of health are assuming responsibility for this type of child health center, sharing the clinical responsibilities with local physicians and dentists. The Children's Bureau envisions the extension of this kind of service to children of school age and to adolescents, with variations in the staff and the nature of service for each group. Health departments are expected to carry the full administrative responsibility for school health and medical services, cooperating with the school authorities for the administration of the school health education program. In states where school health services are now expressly delegated by law to the departments of education, the two departments are urged to work out cooperative arrangements to assure coordination and continuity of service.

Many authorities are giving thoughtful consideration to the trend toward administration of health and medical care by health departments. It is Eliot's firm conviction that the march of events "is slowly but surely placing upon the health agencies of this country the responsibility for the administration of public programs for the treatment of the sick as well as public programs for the control of communicable disease and the general promotion of health." She points out that the wartime EMIC program as well as the services for mothers and children and for crippled children administered by the Children's Bureau provided health departments with experience in the management of medical care programs. This experience would stand them in good stead if a general medical care program should ever be adopted. Mustard, in his consideration of government in public health, does not enter into the pros and cons of medical care provided by the government, but he does point out that "no plan for improvement of public health services in the nation as a whole or in any given state may be approached realistically without a recognition of the fact that the administration of a public medical care program may become the responsibility of the health department. If this should come to pass, much that is done in one way now would then be done in another. Many comfortably established routines would be rudely shaken and it is possible that a hypertrophied medical-care tail would soon wag the none too robust public health dog."[6]

Others are not convinced of the wisdom of lightheartedly saddling the public health officers with the administration of clinical services. There is enough work to be done in the recognized areas of public health without placing other responsibilities upon the shoulders of the public health officers.

The administration of medical care programs by health departments may be furthered through the operation of the Hospital Survey and Construction Act. Although the law has no mandatory provisions for the consolidation of health and hospital programs, the inclusion of public health centers among the facilities for which funds are appropriated is interpreted in some quarters as a basis for integration of the two activities. Developments in New York State suggest the direction that this trend may take. Hitherto health and hospital services have been established more or less independently of one another;

the only county general hospitals in the state are in counties which do not have health departments. There are only three of these, but now that federal funds are available to cover one third of the cost of construction and state funds are available for another third, further expansion of hospital facilities is in prospect. To encourage the establishment of county health departments, the state commissioner of health has promulgated new regulations to the effect that state aid will not be forthcoming for the construction of a county general hospital unless a county health department is organized as well. Moreover, recently enacted legislation provides that a county health commissioner may be the superintendent of a county hospital and that one board of managers may supervise the two services.

Cooperation with Industries. The trends thus far described have involved increases in the responsibilities of local and state health departments. In contradistinction to these trends should be mentioned one trend, particularly visible in the field of sanitation, in which health departments share inspectorial responsibilities with the industries under their supervision.

The federal government elicited this type of cooperation with industry in the early days of the Quarantine Service. For many years the chief method of maintaining rat control consisted of the fumigation of ships when they arrived in port. An offer on the part of the government to exempt ships which were free from rats from this time-consuming and expensive procedure led to the construction of rat-proof vessels. Today 95 per cent or more of American-built ships are so constructed that they do not harbor rats.

In New York City cooperative understanding has been applied to milk inspection. By stimulating the milk industry to assume responsibility for self-inspection, the health department has built up an effective system of control of the New York City milk supply coming from 45,000 dairy farms and amounting to about 3,250,000 quarts daily. This milk is handled in 420 milk-receiving stations in the country and 40 large pasteurizing plants in the city. The prevention of outbreaks of milk-borne disease would not be possible in a city as large as New York without the assistance of the dairy industry. In essence, the self-inspection system means that under the supervision of the health department the dairy industry polices its own procedures, with specific attention to the condition of the animals, the sanitation of the farms and the barns, and the methods of handling milk in the receiving stations and the pasteurizing plants. Without this system, in which milk handlers employ their own inspectors, the health department's staff of 59 field inspectors and administrators would have to be multiplied tenfold. So successful has the arrangement with the milk industry proved to be that the New York City Board of Health has incorporated a new section in the city's Sanitary Code requiring all wholesale and retail food establishments, including restaurants, to develop programs of self-inspection. These establishments may likewise find it to be to their financial interest to meet the health department standards by self-regulatory procedures, thus enhancing their own efficiency and avoiding disciplinary action; meanwhile the taxpayer benefits by the economy effected.

Though less spectacular than the other trends, this trend in the field of environmental sanitation may presage the future course of other health department operations. Detailed services, if coupled with educational efforts designed to stimulate self-discipline and self-control, may eventually be dispensed with so that maximum results can be achieved with a minimum of government activity. Is it possible that other branches of health departments may also achieve this goal when they reach a mature stage of evolutionary development?

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CHAPTER VII

The Hermann M. Biggs Memorial Lecture

The Hospital Survey and Construction Act and a Nation-wide Health Program

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IT is not often that such unreserved praise can be given to an act of the Congress as that gladly bestowed upon Public Law No. 725, passed on August 2, 1946, just prior to the closing of the Seventy-ninth Congress and approved on August 13 by President Truman.

This is officially cited as the Hospital Survey and Construction Act and is an amendment to the Public Health Service Act of 1944. The bill, which has now become law, was popularly known during its consideration by the Congress as the Hill-Burton bill from the names of the introducers, Senators Lister Hill of Alabama and Harold H. Burton of Ohio.

The major credit for the professional origin and for support and promotion of the passage of this act belongs to the American Hospital Association. The drafting of the bill was the joint accomplishment of officers of the American Hospital Association and the Hospital Facilities Section of the States Relations Division of the United States Public Health Service. Support for the bill came from the American Medical Association, the American Public Health Association, the Association of State and Territorial Health Officers, the New York Academy of Medicine, and voluntary agencies concerned with the welfare of the sick and with public medical services. Influences within the federal administration were strongly in its favor. The bill was introduced in the Senate on January 10, 1945. Progress of the bill to enactment was delayed only in the interest of perfecting its details, not by any threats or tactics of opposition. Public hearings revealed no antagonisms of a partisan or practical nature, no objections, social, professional, administrative, or financial. The reasons for this unique train of events and fortunate outcome will appear from consideration of some of the important features of the act. The four parts of the act deal with its purpose, surveys and planning, the construction of hospitals and related facilities, and miscellaneous matters including particularly those of a federal hospital council and state control of operations.

Provisions of the Act. The purpose of the act is to assist the states in making inventories of their existing hospitals and related institutions for the sick, including health centers and outpatient departments; to develop programs for the construction of such facilities as may be required to furnish adequate hospital bed and outpatient services for all the people; and to construct public and other nonprofit hospitals in accordance with such programs. A sum of money is authorized to be appropriated to carry out the declared purposes of the act.

A state must apply for funds to conduct a survey; it must also prepare a program of hospital location and construction which is acceptable to the Surgeon General of the United States Public Health Service. The state can receive one third of the cost of such a survey from sums allotted to each state. These sums are in proportion to the ratio of the state population to the national total.

Fortunately a broadly tested pattern for such a stock-taking of hospital facilities has been developed in the past two years by the Commission on Hospital Care, a voluntary body organized under the auspices of the American Hospital Association and supported by three philanthropic foundations. The Commission has completed studies of eleven representative states and has made comprehensive recommendations appropriate for all the other states. This is an example of a suitable voluntary and professional effort to test methods, disclose characteristic situations and needs, and propose corrective and advanced solutions before the government undertakes to set its hand to a new project of broad social concern. We like to think of this as the wise and thrifty method of democratic progress. It has been a traditional method throughout the history of hospital affairs in this country; the dual system of voluntary and tax-supported institutions for the sick has greatly benefited by the standards and achievements of community general hospitals developed independently of local or state government. We could not be so confident concerning the management of the state surveys, which are to be made with the assistance of federal funds, without the example in content, method, and general philosophy of recommendations already in our hands from the Commission on Hospital Care.

For the construction of hospitals and related facilities $75,000,000 a year is made available for five years under appropriate controls specified by regulations written into the law.

With the approval of the Federal Hospital Council, created by the act, the Surgeon General was required within six months of the enactment to declare the desirable ratios of beds to population in hospitals caring for general conditions, for tuberculosis, and for mental and chronic diseases. The Surgeon General also had to stipulate the methods suitable for bed distribution within each state. These matters have been acted upon and promptly published.

Provision is also made for public health centers in a ratio not to exceed one center for every 30,000 population.

Conditions are laid down as to the priority of importance of hospital facilities for rural areas with small financial resources. Stipulations are also made concerning persons unable to pay for hospital care and access for all persons needing hospital care without regard for race, creed, or color.

There are requirements that a single state agency will be responsible and will be supported by state law in its authority for the survey, for submission of a plan to the Surgeon General, and for the construction of the facilities as approved.

One third of the cost of the construction of hospitals and related facilities approved in the program is to be provided by federal grants. Precautions are included to prevent arbitrary or one-man administrative decisions adverse to the requests of states for aid in building and equipping approved facilities; the Federal Hospital Council has the duty to grant hearings to states if they request a review of the Surgeon General's decisions.

The fourth part of the act includes, among miscellaneous matters, the basis for state allotment of federal funds for construction, with particular reference to more liberal provisions for Alaska and Hawaii, which may receive 50 per cent of the cost of construction of approved facilities, and for Puerto Rico which may receive 75 per cent, whereas the states may receive not more than 33 per cent. Under the term "hospital" are included laboratories, outpatient departments, nurses' home and training facilities, and central facilities operated in connection with hospitals.

The term "public health center" is defined as a publicly owned facility for the provision of public health services, including related facilities such as laboratories, clinics, and administrative offices operated in connection with such centers. Nothing in the term or its definition justifies the assumption that such health center facilities are to provide diagnosis and treatment of general medical, surgical, or maternity patients.

The Federal Hospital Council consists of eight appointed members, four representing the fields of hospital administration and health activities and four representing the public or consumers of hospital facilities, both urban and rural. The members serve overlapping terms of four years. The Surgeon General must consult the Council and in certain situations he must defer to it in matters of regulations, allotment of funds, and approval of state plans. The Council must be called once a year and at any time during the year on the request of three or more members. The Surgeon General shall call a conference of representatives of the state governments once a year and at other times on the request of five or more of the states.

The last section of the act (635) is of special importance as it specifically provides that "no federal officer or employee shall have the right to exercise any supervision or control over the administration, personnel, maintenance, or operation of any hospital with respect to which any funds have been or may be expended under this title."

State initiative, responsibility, and performance are safeguarded and secured, subject only to meeting the reasonable requirement that a state's plan be consistent with good professional and social practice for care of the sick, as defined and interpreted by the Surgeon General with the collaboration of the public's appropriate representatives, the Federal Hospital Council. One could not ask for a more mutually considerate and balanced provision of law designed to equalize the distribution of wealth for the benefit of the less fortunate of our population in respect to hospital facilities.

It is true that there will be less return in kind for the taxpayer's dollar than if the tax monies from each state did not have to go to Washington to be shuffled about and chipped off by federal bureaus and departments before being returned to the state of origin. But we know that none of the wealthy states will voluntarily devote state income or other tax resources to building hospitals in economically dependent states. It is probable also that the persuasiveness—official federal bribery if you will—of the offer of one third of the construction cost of well planned institutions for the sick will lead the respective state governments to spend their two-thirds contribution more liberally than they would do if they had to combat the usual opposing influence of real estate and taxpayers' protective associations in their legislatures. The allotments set up for the construction of hospital facilities give good reason to respect the formula used. The states of California, Connecticut, and New York may receive no more than 24 cents per capita of population, because of their high average per capita incomes, while Alabama, Arkansas, Kentucky, Mississippi, and North and South Carolina will receive more than one dollar per capita, from $1.03 for Kentucky and North Carolina to $1.21 for Mississippi. Such federal assistance as 24 cents per capita for New York State is trifling compared with the more than

$66.52 per capita now invested by the people of New York City in their local hospitals, institutions, and agencies for care of the sick. The annual operating cost of these institutions is not less than $10.17 per capita; each year the people of New York City voluntarily contribute not less than $1.65 per capita to meet the cost.

This act is sound in principle, timely, and welcomed by all who know its purpose. Its administration is to be trusted and its benefits for the sick, for the standards of medical practice, and for its less direct but nonetheless real opportunities to advance medical education are obvious, real, and within early reach.

Health Centers. If one were to express a reservation or regret, it would be because of a certain ambiguity in the name and purpose of the so-called public health centers. There is an implication that combined operation of services for institutional care of the sick individual and administration of the duties of health departments for mass control and prevention of disease could, with some advantage, be carried on by a single representative of state or local government. Yet even this possible cause of confusion would create little alarm among those with competence in health administration were it not for such quotations as the following from persons in federal employment known to be devoted to promoting single dominance over hospital and health services: "The act itself is testimony to the fact that the current conception of public health includes responsibility for treatment and care of the individual."

Nothing is further from the fact. No responsible professional body in the United States has declared itself to be in favor of having the health officer run the community hospital or the hospital administrators run the local health department; no one advocates the inclusion of general care of the sick within the functions of public health.

The act is clearly intended to assist states to provide only buildings and equipment. Each state has a body of public health law defining more or less precisely the functions and responsibilities, the authority and limitations of state and local health departments. In none of this statute law is there expressed a requirement or a permission that the local health department undertake the diagnosis and treatment of the sick person, except when this may be necessary in the event of communicable disease or some emergency situation or where the health officer is called upon in his spare time to serve in the outmoded role of city, county, or poor-law physician. Only in Maryland has state law assigned to the state health department and its district health officers the function of caring for such sick persons as are a proper burden because of their poverty.

Administrative Provisions. To receive benefits under the Hospital Survey and Construction Act, each state will be required to have a hospital law establishing a state agency responsible for survey, plan, and construction and a state advisory council devoted to hospital matters, a sort of counterpart to the state board of health or public health council, which for some decades has been an important part of the structure of most state governments.

Variety is to be expected and hoped for in the patterns of state administration in the hospital field. In most states the law will vest authority in the state health department to meet the requirements of the act. This plan may serve convenience and economy. In fact, at present in about half of the states the administrative relation between the state and federal government in respect to the act is assigned to the state department of health.

Preventive Medicine and Medical Care. There is, however, a matter of difference of principle and purpose involved in the conception of a vocal and insistent minority that public health includes responsibility for treatment of the sick individual. This position is the outgrowth of that urge which has expressed itself in support of a variety of maneuvers to force government dominance over the practice of medicine by financial pressure and administrative concentration of power. The contention of this group is that public health service is a general and inclusive term enveloping care of the sick as well as the authority for protection of the community or social aggregate against preventable disease. This attitude, I believe, runs counter to the best development of the two distinct fields of hospital services and health authority. The other attitude is that the operation of hospitals and kindred institutions for those who require personal medical attention is a highly specialized function requiring particular training and experience, while the direction of a local or state department of health calls for persons equally specialized in training, but commanding quite a different order of scientific and academic disciplines.

Application of the sciences of preventive medicine by civil government for social ends is the purpose of departments of health. Organization of services of diagnosis and treatment of the sick individual by his chosen physician or by groups of physicians is the function of administrators of hospitals. The best interests of the public and of the professions involved will be served if these two well established functions are distinguished from each other, however closely they may collaborate in the use of various facilities.

Let me quote from that delightful expression of biological wisdom and social philosophy, *Man, Real and Ideal,* in which E. G. Conklin offers much mature and fruitful opinion. In social as in biological evolution (of which the social may be considered a part) "there has been general progress from the simpler and more generalized to the more complex and specialized forms of life."[1]

Public health departments and hospital institutions seem to me to be highly specialized and differentiated instruments of social progress, the one essential to safeguard the community against disease, the other essential to serve the sick individual. To quote Conklin's paraphrase from C. O. Whitman: "Specialization and organization are companion principles of all progress, . . . whether phylogenetic, ontogenetic, individual, or social; all involve increasing specialization and cooperation.

But at present in human society, differentiation has outrun integration, specialization is far in advance of cooperation. Science is promoting social progress by increasing the possibility or rather the necessity of specialization and cooperation among all men." And further from Conklin himself, "Forced cooperation has often failed in the past when tried on a smaller scale, whereas the democratic process of cooperation through persuasion, education, and majority rule has measurably succeeded, particularly in these United States."[2]

Only by violence to the structure of sanitary law, created over the eight decades since Dorman B. Eaton wrote the broad principles of public health authority into the New York State law which established the metropolitan board of health of New York in 1865, can such a combined public machinery for care of the sick be created. And to quote again from Conklin, "This shattering of things to bits in order to remould them nearer to the heart's desire is the method of revolution rather than that of evolution, of tyranny and compulsion rather than of freedom and education, of autocracy rather than of democracy. Nowhere in the living world is progress brought about by shattering things to bits, but rather by relatively minor changes in organization—truth cannot be established by compulsion, nor error permanently overcome by force."[3]

There is some talk and writing in favor of one glorious and comprehensive medical service station, institution, or department of government to which the sick and well alike will come clamoring for recovery from illness or for better health. Promoters of this vision of merged functions are chiefly drawn from among those who are either untrained in the specialty of medical administration or who have not carried the responsibility for personal or public health as a chosen field in the practice of medicine. There is to my knowledge only one instance of a physician serving as a commissioner of city government with distinction and universal public approval in each of the fields of public health and hospital administration. I refer to the signal services in these fields rendered by the late Dr. S. S. Goldwater of New York, and it will be recalled that he did not serve in both capacities at the same time. Goldwater, a physician of rare and unusual administrative capacities and imagination, made notable contributions to the content, methods, and results of health protection as Commissioner of Health in 1914 and 1915, and as Commissioner of Hospitals of New York from 1934 to 1940, he set standards of performance for humane and scientific care of sick persons never before attained in our municipal hospitals. In each position Goldwater found that the demands of the job required his undivided concentration.

There appear to have been two kinds of civic and educational decisions which will probably move our development of health departments and hospitals more and more toward specialization. One of these is the 1938 charter provision in New York for three separate departments of health, hospitals, and welfare, an example followed in some other large cities such as St. Louis and Philadelphia, where there has been a separation of city hospital care from under its former locus in the department of health. This seems to me a wise tendency in government at a state or city level, although not always equally applicable to small units of local jurisdiction.

The other decision is the establishment of schools in half a dozen universities for the training of hospital administrators. These schools offer curricula of quite different content from those considered basic at schools of public health. Wise choice of the hospital administrator and the health officer will increasingly lean toward those with such special educational equipment. The graduates of these two types of vocational university schools are not interchangeable so far as civil service is concerned.

Let me urge your thinking and opinion in the direction of perfecting that amazingly potent instrument of closely knit services for the sick, the general hospital. Do not look with covetous eyes upon that equally essential servant of civil government, the department of health, which calls for other qualifications and yet demands similar public promotion.

Let us first agree to put forth all the influence of society, of the competent professions, and of our state and local governments to obtain maximum benefits for the sick out of the favorable opportunity now offered to the states for expansion and for comprehensive coverage of our people through hospitals and kindred institutions. At least the Hospital Survey and Construction Act gives us the hope that we may achieve for each community, however small and remote in location, the elements of competent care as nearly as possible equivalent to those in the great cities of our land. This is properly the first and dearest medical ambition of our people, just as the primary function of the physician is to recognize illness and relieve it if he cannot cure it. The physician with modern training will more readily go to remote and impoverished communities if there are a hospital and a laboratory at the service of his patients. The health center building without the staff and organization of a local health department would be lost in a social vacuum much as a hospital would be without an administrator and a medical board.

The second job, well begun in the cities and in a very few states but still unfinished for more than 41,000,000 people, mostly those in the same small towns and rural counties still lacking hospital facilities, is the provision of a health department of the simplest basic type under competent professional direction. Second to the need of modern facilities for care of the sick is the provision under local government of the half-dozen indispensable functions of a health department. Within the administrative jurisdiction of the health department will fall each square mile and population unit of our nation.

At our present rate of progress it will take a hundred years to achieve this. To those of us in New York City who take for granted the more or less creditable services of our five-county, single-headed city department and board of health, a continuing activity since 1865, it is almost unbelievable that more than 41,000,000 of our fellow Americans lack anything comparable. In fact, only five states and the District of Columbia have covered their populations with basic local health services under full-time medical health officers, and New York is not one of these. We do not think of Iowa as a backward or impoverished state and yet more than 96 per cent of its people live in communities without even elementary local public health services. Scarcely two thirds of the people of the United States live where there is a local health department even in name. These unprotected communities may have a *pro forma* board of health but without a medical health officer trained for such work. In hundreds of communities the part-time health officer has had no medical education or other technical qualifications for the position. Public health services of the least ambitious kind include four functions which operate largely through the use of public authority and two that depend wholly upon educational resources. These six functions can in their simplest form be carried on at a cost of one dollar per capita if the unit of population is of a suitable size. The average expenditure for local health services in the United States is 65 cents per capita.

Provision for Local Health Administration. We cannot be said to have a health plan or program on a nation-wide basis unless we include precise specifications for the conduct and support of local health departments serving all the people. So simple and obvious are these needs that further argument seems hardly justified. But lest you be lulled into a sense of empty national pride and satisfaction by being told that there is a national health plan or a presidential, congressional, or professional health program for the nation, let me warn you of the fallacy of any such forms of political anesthesia. People are easily put to sleep by the announcement that some senator, committee, bureau, or administrative board has a national health program. This may mean an immature proposal for compulsory sickness insurance, miscalled health insurance, or a policy for subsidizing states to meet the cost of care of the indigent sick, or any other catch-penny and catch-vote device that seems to be popular with the press or with self-anointed keepers of the social conscience or imagination.

There is unfinished business on the agenda of official public health work. There are growing and insistent needs and demands for modern medical care. There are serious inadequacies in the quantity and quality of the various professions and technologies engaged in applying the sciences of human biology for both the sick and the well. But there is no really well-thought-out national health plan before us. Only patchwork is apparent, additions, supplements, extensions of one phase or another of what should be a balanced undertaking without disproportion or deficit in any essential function, agreed upon after conference both by the responsible professions and by competent officers of government, federal, state, and local.

Leaving the basic structure of local health departments a scant two thirds completed while expensive and elaborate additions are made for the half-dozen special duties of the health officer makes for a very lopsided house of health. Federal funds have been poured out for mothers and babies, for crippled children, for the control of tuberculosis, for venereal diseases, and for the study of cancer and mental disease, while the machinery of state and local government lacks the means to operate the essential basic services. Pressure groups within and without the federal government have influenced the courses taken by the Congress. It would be far better for organizations of state and territorial health officers and members of the public health profession to present necessary information formally at the request of the Congress. Without the basic structure of local health departments through which services can be delivered retail to every community and family, there can be no health plan for the nation at any level.

I venture to claim that the Hospital Survey and Construction Act is the first substantial gesture of the national government to support a national program for the care of the sick. Further I would warn you that more physicians, more hospitals, and more doctoring of the sick cannot by themselves be trusted to improve materially the health status of our people, much as they will add to humanity, to gentleness, and to comfort in sickness. The nation's health, the higher levels of living longer, fuller, broader, deeper lives will be built of other elements of service than those of the hospital, the dispensary, the operating room, or the convalescent home.

Health in the national sense will be built of services and civil government functions of quite a different order. Prevention, protection, and the promotion of health and the fullness of life will be the products of applied biology, sanitation, epidemiology, immunology, and education in the phenomena of living matter—the creation of ethics of personal conduct consistent with the best quality of life.

The least that can be accepted as services of a local health department are registering and interpreting the facts of birth, sickness, and death, the control of communicable diseases, the management of man's environment through the science of sanitation, and the use of the public health laboratory. Each of these four services requires in some respect the exercise of the authority and police power of the state. We can also do much for maternal and child health and for many preventable conditions of ill health at all ages through the almost unlimited resources of education for health.

All these activities require personal relationships between health agents of local government and the homes, farms, shops, industries, offices, schools, and play places of the communities. We shall never achieve better health by international conventions or national health organization, nor can we expect great health profit from state departments of health alone. It is through the protection, encouragement, and guidance of maternity and the growth and development of infants and children through adolescence to maturity that public health is contributing most to contemporary society and offers the largest hope for the future. Society has more at stake in the process of its own replacement, in the quantity and quality of human reproduction, than in any other field of preventive health services.

The first and most urgent obligation of each state government is to see that legislation and administrative planning are such that they will produce a local health department for every county, multi-county, city-county, or district unit in the state of suitable size to justify the employment of the professional staff needed for competent performance of the task.

If the modest cost of such local coverage cannot be paid for without hardship from local taxes, state or federal grants will have to meet it; but in all events the local unit should pay a substantial part of the cost of this necessity.

And here we come back to the lesson of the Hospital Survey and Construction Act, which offers us a pattern and philosophy of federal-states relationship that we can follow with advantage. The American Public Health Association, with the full endorsement of the Association of State and Territorial Health Officers and the American Medical Association, has prepared a plan for local health services in each of the forty-eight states. The plan is based on careful studies expressed in formal publications, all complete with estimates concerning personnel, budget, and the like.

I can think of no way in which the influence and financial encouragement of the federal government could be so effectively applied to raise the level of national health as in the creation of local health departments in areas where they are still lacking. A law authorizing federal grants-in-aid to assist in meeting the cost of local health units would expedite the completion of the task of total coverage by several decades and at a fraction of the cost required by the hospital act.

For a few years we shall be short of health officers, public health nurses, sanitary engineers, health educators, and some other professional personnel to do the whole job throughout the nation; but by the time the states' plans are matured and accepted and the Congress has passed the necessary act, such limitations in qualified health personnel should have been overcome by newly trained graduates of our universities. With the hospital act and the kind of parallel health act that is suggested here, we should be far along the road to a balanced and integrated use of each of the fields of administrative medicine, and all without violence to the existing and well tested resources of medicine.

Summary. It is an Aristotelian aphorism that the philosopher should begin with medicine, and the physician end with philosophy. A contemporary university philosopher told us recently that philosophy is grounded in the natural sciences, among which we certainly include the medical sciences. I hope that the spirit of our occasion will move you who are not physicians to develop and act upon a philosophy that will mold our democracy into patterns consistent with the teachings of biology. Can I ask more of fellow physicians than that their medical philosophy be not inconsistent with the ambitions of society?

Coleridge bid us "Pronounce meditatively the name of Jenner, and ask what might we not hope, what need we deem unattainable, if all the time, the effort, the skill we waste in making ourselves miserable through vice and error, and vicious through misery, were embodied and marshalled to a systematic war against the existing evils of nature."

Any proposal for the betterment of health and medical care among the people of this or any other nation worthy of consideration as a plan or program of action, whether legislative, social, financial, or professional, must include provision for the following:

1. Advancement of knowledge as to the causes, recognition, treatment, and prevention of disease and progress in the broad fields of human biology.

2. Progressive improvement in the education of physicians and health officers, nurses, sanitary engineers, and a host of indispensable related professions and technologies.

3. Hospital and laboratory facilities available for all qualified physicians and at the service of all sick persons needing them.

4. Local health departments to serve all the communities and areas of jurisdiction of civil government of our states with appropriate supplementary support from state, national, and international health authorities.

The first of these goals has been sedulously sought by the contributors to science in our educational and research institutions, both private and governmental, in independent as well as coordinated efforts. Great advances are to be expected in scientific research if the national science foundation is established by law and is wisely and liberally administered.

Education in the professions and associated arts, sciences, and vocations can best be left to the institutions of learning which have long carried this responsibility. To facilitate or hasten the preparation of persons urgently needed to make up for the deficits created by wartime interference with graduate education in the sciences, some further federal aid may be required beyond what is now being given to war veterans. It is, however, not at all certain or clear from past experience that paying students to be educated in the medical sciences and arts by public subsidy is the wisest way of securing the best qualified candidates.

The third field is in process of being fairly dealt with under the Hospital Survey and Construction Act. Congress is also giving consideration to supplementary measures which are designed to assure good quality and a better spread of medical care for the indigent by extending federal aid through departments of welfare or other agencies of state and local government.

In order to provide health services on a nation-wide basis, we must have complete coverage of the nation by local health departments under trained medical officers with associated staff. Such coverage should be supported largely if not wholly by local tax funds, with state and federal aid where necessary.

We still hope, after a half-century of repeated demands, for a cabinet department devoted to the medical interests and functions of the federal government. Also, there are heavy international obligations we should meet as part of any national health plan. But without at least the four elements outlined above, we shall not have anything worthy of the name of a national health plan.

We grandly declare our concern for the survival of the uncounted millions, actual or potential citizens of the One World that barely contains the controversies of the wrangling nations. Let us put our own house in order and strengthen our precepts in the eyes of the outlander by the example of good performance at home. To borrow again from Conklin, let me remind you that "the greatest problems that confront mankind are how to promote social cooperation, how to increase loyalty to truth, how to promote justice, how to expand ethics until it embraces all mankind."[4]

"We are today only children in the morning of time, and before us lie the countless centuries and millennia of man's vast future."[5]

REFERENCES

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2. *Ibid.,* pp. 42–43.
3. *Ibid.,* p. 216.
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CHAPTER VIII

The Preparation of Professional Workers in the Field of Public Health

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The importance of educating the public with regard to the significance of the public health program and mobilizing support for the objectives of that program emphasizes the importance of training leaders in this field, for leadership is the primary factor in community organization and the trained teacher must be the center of any wider scheme of education. How shall we find the right leaders? How shall we teach the teachers?

These are the problems placed before the Committee on Professional Education of the American Public Health Association, problems which it has approached with notable success in recent years, under the very able chairmanship of W. P. Shepard of San Francisco.

The first task of this committee was to formulate general standards for the qualifications required to perform various sorts of specific public health functions. This task was a complex one, since it involved a wide variety of highly differentiated specialists—the health officer or health administrator; the physician directing a division of communicable disease control, tuberculosis control, venereal disease control, mental hygiene, or industrial hygiene; the public health dentist and the public health nurse; the public health engineer, the public health statistician, the public health laboratory director, and the health educator. The Committee has now formulated detailed qualifications for fifteen different specialties in public health and these statements have been accepted by many health departments and civil service commissions throughout the country. As Shepard has said, "These reports are serving a useful purpose in three directions: (a) as guides to appointing bodies where their increasing use in job specifications has been most gratifying; (b) as guides to prospective candidates for careers in public health; and (c) as guides to teaching institutions."

A second important assignment of the Committee was the development of a merit system service. This service has prepared—with the counsel of psychologists and personnel experts—an extensive set of examinations by which the applicants for a given post may be readily and soundly graded as to their fitness for the task. These examinations have been utilized in thirty-three states with highly satisfactory results. They now cover nurses, laboratory personnel, sanitarians, health officers, health educators, nutritionists, statisticians, and medical social workers.

Three years ago the Committee undertook a third major task, accrediting the schools of public health in which the various types of health experts are to be trained. Both the United States Public Health Service and the Association of Schools of Public Health asked the American Public Health Association to assume this responsibility.

The Executive Board of the American Public Health Association, on the recommendation of the Committee on Professional Education, established in 1946 (and modified in minor respects in 1947) a set of minimum requirements for institutions to be accredited, covering general university status, essential faculty, housing and other facilities, availability of local administrative health units for demonstration, requirements for admission to the M.P.H.[1] and Dr.P.H. degrees, general course requirements, adequacy of the curriculum offered, and opportunities for advanced research and specialization. Survey visits were made to all the schools in 1945–1946 and 1946–1947 and certain of the general findings of these surveys may be briefly summarized.

Ten universities are now formally accredited for the M.P.H. degree: California, Columbia, Harvard, Johns Hopkins, Michigan, Minnesota, North Carolina, Toronto, Vanderbilt,[2] and Yale. California, Columbia, Harvard, Johns Hopkins, Michigan, North Carolina, and Yale are also accredited for the Dr.P.H. degree.

The ten schools studied have widely different orientations in the framework of the university. Four are completely independent units reporting directly to the president or his representative. Two schools are officially only departments of the medical school. Four other types of relationship to medical schools or graduate schools are represented between these two extremes. In all cases, however, the school or department concerned enjoys practically effective autonomy, which is our first minimum requirement.

Our second basic criterion relates to the faculty and requires, as a minimum, at least six full-time faculty members of professorial or associate professorial grade. In the year 1946–1947 there were 128 such senior faculty members in the ten schools,[3] the number in an individual school ranging from eight to twenty-two.

It is of interest to note that vital statistics is represented by a full-time senior faculty member in every school. Epidemiology, sanitation, and public health practice are so represented in nine schools; microbiology in seven schools; and health education in six schools. Nutrition has a full-time senior faculty member in only five schools and physiological hygiene in only four schools. This seems strange, since the problems relating to nutrition, fatigue, recreation, illumination, and the influence of the atmospheric environment upon health and the like will probably be more important than the control of communicable disease in the future development of public health in the continental United States. It is particularly unfortunate that only two schools have full-time senior faculty members in the field of mental hygiene and that only one school has a full-time appointee in the field of social and economic factors in disease (including medical care).[4]

You cannot train professional public health workers without funds. We have therefore analyzed this problem with some care. The "effective budget" of the schools studied is the sum actually available for training graduate students in public health, excluding time devoted to the teaching of medical undergraduates and other university students and also excluding special grants for major research projects supporting groups outside the teaching staff. In the schools studied, this budget varied in 1946–1947 from $53,000 to $307,000 and averaged $158,000. A budget of $100,000 should, in general, be considered as a minimum. The two schools which at present fall below this figure are enabled to perform their tasks only by drawing heavily on other university facilities.[5] Our analysis shows that the cost per student averages $3,750, ranging from $2,800 to $4,900. This is not a type of professional education which can be financed on a shoestring.

Four schools are housed in their own independent buildings, five in buildings shared with other university departments, and one in a building shared with the local health department. Only one of the ten schools feels that its present quarters are wholly adequate, but essential minimum requirements are met in all of them. All of the ten schools have satisfactory facilities for observation of local administrative health services. Methods for developing field instruction have been worked out at several schools and are of the greatest pedagogic interest.

The minimum requirements for admission to the M.P.H. course have been fixed as follows:

Candidates to be admitted for the degree of Master of Public Health (Diploma of Public Health in Canada) may be either (a) holders of the degree of M.D., D.D.S., or D.V.M. or equivalent degree from an acceptable institution; or (b) holders of the Bachelor's degree with adequate training in mathematics and the natural sciences, including chemistry and biology, and also qualified in some professional capacity to pursue education in public health. The latter qualification may be fulfilled either by (a) professional academic qualifications in engineering, public health nursing, education, or some other field of public health representing the equivalent of at least one year of graduate work, in addition to the completion of a four-year course leading to the Bachelor's degree; or (b) three years of experience in some field of public health practice of a type acceptable to the school.

Thus, this degree is placed on what might be called a post-postgraduate level. It represents one academic year of basic training which turns the physician into a public health physician, the engineer into a public health engineer, the statistician into a public health statistician, and so on.

During the academic year of 1946–1947, 369 candidates were registered for the M.P.H. in the ten schools (the candidates ranged from four in two schools[6] to eighty in one school). These candidates were distributed as follows with regard to qualifications for matriculation:

Physicians	224
Dentists	11
Veterinarians	7
Bachelor's degree plus additional graduate qualifications plus three years' experience	22
Bachelor's degree plus additional graduate qualifications	12
Bachelor's degree plus three years' experience	73
Bachelor's degree plus an extra year in the school of public health	8
Bachelor's degree, without full completion of year's graduate study	12
	369

The last twelve students listed were registered through misunderstanding of minimum requirements during the first year of the accrediting program.[7]

The course for the M.P.H. occupies one normal academic year. In many schools it calls for additional practical supervised field experience in the case of students who have not had such experience prior to matriculation.

The character of the courses offered for the degree of M.P.H. varies widely. This seems highly desirable and we should deplore any attempt at such rigid standardization as obtains in certain other professional fields. One school has a completely scheduled and required full-year curriculum of 1,040 hours. At the other extreme is one school which prides itself on having no required courses at all. Some schools have established more or less fixed options (in one case, fourteen of them). Other schools require certain courses and arrange additional electives to suit individual needs. All schools require (or practically require) courses in sanitation, vital statistics, and public health practice. All but one require epidemiology and all but two microbiology. Physiological hygiene and parasitology are each required in four schools.

Elective offerings yield much the same picture. Every school provides one to thirteen courses in sanitation; two to ten courses in vital statistics; two to seven courses in epidemiology; one to sixteen courses in microbiology; one to nine courses in public health practice; and one to four courses in industrial health.

Other subjects are emphasized as follows:

Number of Schools Offering Courses in Specified Fields

Health education	9
Physiological hygiene	8
Social and economic factors	8
Maternal and child health	8
Public health nursing	7
Mental hygiene	7
School health	7
Nutrition	6
Parasitology	6

Venereal disease control	6
Tuberculosis control	5
Public health dentistry	4
History of public health	3
Public health law	2
Cancer control	1
Sanitary chemistry	1
Military medicine	1

On the whole, the balance of subject matter seems to have been well worked out in most of the schools. It must be remembered, of course, that subjects such as social and economic factors and public health law may be, and sometimes are, well treated in a section of the course in public health practice in schools where no special course is listed under a separate heading. Furthermore, it is altogether wholesome and desirable that many specialties, such as maternal and child health, school health, parasitology, venereal disease control, tuberculosis control, and public health dentistry, should be emphasized in some schools and not in others. In some schools, epidemiology is the basic central element in the curriculum and this is a discipline which can be, and is, developed so as to provide a broad cultural philosophy. In others, administrative health practice is the dominant motive. In some, the far-reaching implications of modern social trends as they are influencing present-day health service receive special emphasis. All this variation is to the good.

It does seem, however, that physiological hygiene and social and economic factors in public health are of such fundamental and basic significance for the future of health practice that they should receive serious attention in all schools and much more emphasis than they now receive in most schools. It would appear that well equipped laboratories for fundamental research in these fields are as essential as similar laboratories for microbiology, epidemiology, and statistics. Such provision is today found in only one school for social and economic factors and in two schools for physiological hygiene.

Furthermore, it would appear that mental hygiene and public health nursing should be considered on a somewhat different plane from the various specialties listed in a preceding paragraph. Mental hygiene is not a small corner of the total public health problem, but more nearly half of it, and public health nursing demands over a third of the total budget of any well organized health department. It may be argued that specific and organized instruction in both these fields should be an essential part of the training of every public health worker.

In view of the cultural and philosophical importance of the history of public health it seems unfortunate that only three schools have special courses in this field. In one of these three the course has not yet been actually given and in another it is a very brief analysis of one particular historical period.

The degree of Doctor of Public Health is generally limited to holders of the M.D. degree although "in exceptional cases, holders of other doctoral degrees, as in philosophy, engineering, or dentistry, may be accepted." It requires prior completion of basic courses equivalent to those required for the M.P.H. and, in addition, the completion of an additional postgraduate year of academic work in residence, involving advanced specialization in the particular area of public health for which the student is preparing. A minimum of two years beyond the period spent in acquiring prior doctoral degrees is required. The candidate must "indicate capacity to make substantial contributions to the advancement of the science and art of public health by submitting a dissertation based on original research," and he must "demonstrate ability for leadership in his field, as well as for advancement of scientific knowledge." Thus this degree makes more exacting requirements than any other degree offered by our universities.

During the present academic year, only twelve candidates are registered for the degree of Dr.P.H. Two of the schools accredited for this degree have no candidates; one school has one candidate; two schools, two candidates; one school, three candidates; and one school, four candidates.[8]

Finally, the minimum requirements provide that in each school offering either the M.P.H. or the Dr.P.H. there must be opportunity for advanced specialization. It is pointed out that while there will be little time available in the M.P.H. year for advanced specialization, "basic work can be conducted effectively only in an atmosphere of advanced scholarship and with the essential stimulus which comes from the conduct of productive research by the faculty and advanced students." In this respect all the accredited schools are acceptable, and certain schools have considerable sums for research projects (the sums range from $15,000 to $268,000 in individual cases) in addition to their basic teaching budgets.

In general, the picture presented in this survey has been a heartening one. A relatively new venture in university education is off to a good start on a generally sound basis and with a diversity and a pioneering spirit which should be preserved. The flow of graduates from the schools is not quite sufficient to meet our estimated needs, and certain considerable sections of the country could utilize and could support schools which are now lacking. With the expansion of the smaller of the present schools and the addition of three or four schools, our problem on this continent could be solved. The lines for future progress have, we believe, been soundly laid. In connection with the program, Shepard has said, "To our knowledge, there are no graduates with the M.P.H. or the Dr.P.H. coming from unaccredited schools in this country. To our knowledge, no school has been coerced into applying for accreditation; all have applied voluntarily. To our knowledge, no able public health career person with good experience but without a degree has been denied an appointment on the grounds that he lacked a graduate degree. So far as we know today, no educational institution is planning to establish a school of public health without considering its ability to meet the criteria for accreditation. Our accreditation consultant has been invited to visit and advise several schools which have such plans in mind."[9] We trust that the accreditation program of the American Public Health Association may continue to serve as a useful check on the development of educational efforts of a type unsuited to the arduous and necessarily costly task of preparing professional personnel in the field of public health.

NOTES AND REFERENCES

1. The Diploma in Public Health awarded in Canada is considered as the equivalent of the M.P.H. and is treated by the Committee on the same basis.
2. For 1948–1949, Vanderbilt (which has abandoned its school) has been dropped from the list and Tulane added.
3. For 1947–1948, the number has risen to 155.
4. This figure has risen to four schools for 1947–1948.
5. For 1947–1948 the average budget has risen to $213,000 and only one school is below $100,000.
6. One of these is a new school just starting. The other registered only physicians for the M.P.H. but had 62 students registered for the M.S.P.H., which is not a degree accepted for accreditation.
7. For 1947–1948 the total number of students rose to 444 and only 8 were below admission standards.
8. There were 20 candidates for this degree in 1947–1948.
9. William P. Shepard: "The Professionalization of Public Health," *Am. J. Pub. Health,* 38:151, January 1948.

CHAPTER IX

Education of the Layman in Health Responsibilities

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IMPROVEMENT of the public health is blocked by the layman's unpreparedness to do his part. He fails to cooperate, but not because he is indolent or perverse. He accords small financial support, but not because he is ungenerous. He is simply unawakened and ignorant. He needs to be aroused and he needs to be informed. These results cannot be achieved easily or quickly. They call for a program that goes to the roots of the matter, and the roots are deep and numerous.

The layman, as such, is incompetent in almost everything that he does. In his family life he is unprepared for twentieth-century responsibilities. In his citizenship he is illiterate, blundering first in one wrong direction, then in another. In his economic affairs he is mired in complexities that are quite beyond his powers of extrication. In his recreations he cannot distinguish those that upbuild from those that undermine. In the maintenance of an understanding of the current world he knows neither his responsibilities nor how to discharge them. In his reading, radio, motion pictures, conversation, religion, community life, consumer activities, the upbringing of his children, and most other occupations outside his vocation, he is a hit-or-miss individual who is sometimes right by impulse or accident, sometimes wrong by impulse or accident, but rarely able to follow consistently the ways of understanding. In short, the American layman is a thoroughgoing incompetent.

And why should he be otherwise? He has never been taught the ways of laymanship. This is the age of the expert. The layman is a primitive, a survival from the ox-cart era, a flounderer in everything outside his job. Only the men who have specialized are competent. The modern way is for the experts to take over the layman's functions, to think for him, plan for him, direct him, and get things done far better than he can ever hope to do them for himself. Why, then, should we educate the layman for something he is not going to do? The job of the schools is to train the experts and let the laymen go.

This conception of the relationship of experts to laymen has paralyzed the program of high schools and liberal arts colleges. It has left them without educative functions. Literacy is achieved by the age of twelve or fourteen. At that age the pupils are still children. They have not chosen a vocation and hence cannot yet specialize. They are too immature and irresponsible to begin work that requires the adult outlook. They will simply have to wait until they are eighteen or twenty when they will be mature enough to begin technical or professional training. This leaves a gap of four, six, or eight years, covering most of the adolescent period, during which the high school and junior college have nothing definite to train the young people for. As a consequence, they train for nothing definite.

If anyone doubts that statement, let him ask a hundred high school or junior college faculty members to mention the definite human functions for which they are training the young people. He will get a hundred different answers, not one of them definite. He will learn that during the priceless years of adolescence, the young people are "just going to school" and taking courses without any clear purpose that either the schools or the customers can explain.

Let hunters hunt by just firing into the air; they will not get any game. They are not even hunting. Let educators educate by aiming at nothing in particular; they will achieve nothing in particular. They are not educating. The waiting years are wasted years.

The in-between schools are basically advanced day nurseries for what would otherwise be troublesome adolescents. They are impressive and inspiring custodial institutions, spacious and dignified with ivy-covered walls and cap-and-gown atmosphere, where heady and restive youths can be kept safe, sound, and out of mischief until they mature enough to begin their professional education. These schools have invented highly effective placebos to keep the young people occupied and contented: basketball, football, and other competitive athletics and numerous social activities. These enable the young people to work off the more turbulent of their adolescent spirits. The schools can then operate a program of studies that resembles what we have come to think of as education. In reality this is education without purpose, since the programs do not aim at the shaping or improvement of any definite human functions.

The basic error of high schools and liberal arts colleges is their misvaluation of the layman. Everyone is a layman for three quarters of his time and a specialist for about one quarter. He works at his specialty for from thirty to fifty hours a week; he lives as a layman for from one hundred to one hundred and twenty hours a week. During the longer period he lives as an all-around human being. He carries on his physical living, health care, family life, community life, consumer activities, amateur arts, citizenship, leisure occupations, religion, emotional life, and the endless observation, conversation, meditation, reading, and listening that maintain his understanding.

These areas of the layman's living have not been taken over by the experts. So long as we maintain the American way of life, they will not be taken over by the experts. Every well rounded man exercises his powers in freedom. To subordinate himself to regimentation by the expert is to renounce his sovereignty as a man. His functions as a layman are not superseded; they are the trunk line of human living. The specializations are secondary; their function is to serve.

The trunk line of human living runs through the million complexities of the modern world. The right ways of life are hard to find; they are hard to hold to. The layman has need of much definite education for laymanship. We have the time: the wasted years can be used for the purpose. We have the schools: the high schools and junior colleges have not yet assumed their responsibilities.

Genuine education is not aimless. It is the process of creating definite proficiencies. The responsibility of high schools and junior colleges is to create competent laymen. They have not even tried to do this.

These statements do not exaggerate. Read the recent Harvard report on the education of the layman in a free society. The report announces that two years and $60,000 were spent on the problem; but not even the function of the high school or the college of liberal arts was discovered. The program laid out has not the remotest relation to the layman's educational needs. Yet the report expresses the time-hallowed attitude of schools, colleges, and customers. Look at the pronouncements of the college entrance boards and the school-accrediting associations that regiment the programs of high schools and junior colleges. They accord almost no recognition to the main trunk line of human living. They still think that by firing into the air they will hit the target.

The education of the layman is not neglected because we do not know how to go about it. We know how. At its best our technical and professional education is highly successful. It shows the pattern of education necessary for useful functioning in any field. Competence in a calling is competence in doing the thinking, the planning, and the practical work. Give the individual vocational responsibility, have him do the head-work, the hand-work, and the muscle-work as well as he can until he can do this work responsibly and well—that is the whole pattern.

Competence in any lay function, as, for example, health care, is likewise competence in thinking, planning, and practical execution. Put the responsibility for prudent health care on the lay learner, help him to the necessary understanding, have him do the head-work, and hold him to careful performance until he can think and act responsibly and well; the process will give him genuine education for the health field. It is the apprenticeship pattern and it is applicable to every field.

For any kind of useful education, whether for head-work or for hand-work, doing is the goal, doing is the measure, and doing is the method. Power to function grows from exercise of function. No alternative plan has ever been discovered. There can be no substitute that is not fraudulent.

The principle that life is learned by an apprenticeship process of living was operating in the animal world ten million years ago. It operated in the human world ten thousand years ago. It was voiced by Aristotle, who said: "The thing you would do after you have learned it, you learn by doing it." This is the central principle of educational common sense known to all men. It is the central principle of educational science. It is known to every boy learning to skate or throw a ball. It is known to every musician learning his instrument and to every surgeon learning his skills. It was the method recently employed, with wide acclaim, in creating the urgently needed proficiencies of our armed forces. And yet, proclaim this basic principle of functioning as loudly as you will, the academic schools will not even consider it. The reason is clear. So long as they do not aim at making people proficient in what they do, the principle does not apply.

It is not pleasant to point out how completely our middle schools have missed the road. But it has to be done. In the world's current breakdown it is not the expert technicians who have failed; their inspiring advance is unchecked. It is the sovereign laymen, ignorant, indifferent, and incompetent, who have failed, because education has refused to recognize their needs.

The explanation lies in the simple principle: Demand determines supply. The nature of the demand for educational service determines the kind of service that will be given. The customers demand literacy and they get it because their demand is definite. They want their children to be trained to make a good living, and in technical and professional schools they get what they demand. But for the years from twelve or fourteen up to eighteen or twenty, the customers make no definite demand. The schools fail because there is no lay demand, and the lack of demand is due to the customers' being unawakened to their needs.

This vicious circle can be broken. For example, not many generations ago education for universal literacy was blocked by the layman's ignorance and indifference. But when the layman was brought to see and understand his need of literacy, he wanted it. His wants set into operation forces that solved the whole problem. Wants are the power that drive all human effort. Any vicious circle is simply an area of inertness produced by absence of wants. Let them be awakened and they banish the inertness as light banishes darkness.

Wants awaken automatically when there is a clear perception of the needs. Half a century ago people needed literacy; they also needed vitamins. They wanted literacy because they understood their needs. They did not want vitamins because they did not understand their needs. But today they want vitamins about as much as they want literacy. This change was brought about by awakening a realization of their needs. This realization is at present pathetically incomplete and superficial; nonetheless it is powerful. The character of the foods on the market, the advertising, and the volume of vitamins sold all testify to the power of the urge that issues from explicit comprehension of needs.

In the health area the basic task is to bring laymen to see clearly the entire range of their needs. We assume that all phases of health effort aim at one thing, namely, the improved health of individuals. The desire of the individual for health for himself and for his family is his primary want. It supplies the drive for everything in the health area. It manifests itself as a desire for proficiency in personal hygiene, for adequate medical care, for an efficient public health service to stand guard over general health conditions, and for school and community health programs that will provide all the needed apprenticeship training in good health care.

Let there be a genuine and well matured understanding of these features in the health area, and the wants will arise of themselves. But a genuine and well matured understanding cannot be given to people by merely telling them things. Verbal presentations unrelated to doing are ineffective. This is why purely academic teaching is largely a waste of time.

Wants are indispensable for drive, but they can easily be discharged through the wrong channels. Of equal necessity is guidance. In our complex age blind wants lead one astray; they usually propel people in the right general direction, but they are too vague and crude to guide specific performance. Wants for hurtful things drive tens of millions to injurious behavior and many to premature destruction.

Nature testifies to the need for accurate guidance. Millions of years ago she gave her creatures eyes and the beginnings of intelligence. The gradual enlargement of the brain and the intelligence through the ages is clear proof of the need for accurate guidance. Seeing with the eyes and with the stored vision that lies back of the eyes is nature's supreme method; in its most accurate form we call it science. Science is simply man's clearest vision of the realities of every kind, tangible and intangible, that make up the world. There can be no question, then, as to how health activities are to be guided. Those of the medical specialist are to be guided by the specialist's kind of science as it operates in the specialist's mind; those of the layman by the layman's kind of science as it rules in the layman's mind.

Science for laymen and science for specialists are two versions of the same thing, one simple, the other complex. Both kinds are valid; both, sound. They are equally necessary, since both specialist and layman need the wisdom of science. But one kind will not serve both purposes. The layman cannot possibly use the specialist's science. Conversely, the layman's science will not serve the purposes of the specialist. Proper guidance requires two versions.

In the matter of foods, for example, the physician needs the specialist's science of nutrition to guide his professional judgment, and the layman needs the layman's science of nutrition to guide his daily judgment. But their tasks are different. The doctor deals with conditions that have got out of hand and are abnormal. The layman is concerned with simpler and more easily managed normal conditions. His task is to keep things going day by day within the fairly wide limits of the normal. When things get out of hand, he turns them over to the physician. Nature has produced an organism of great resiliency. For example, it is biologically fitted for much leeway in the food intake. Nature has always expected man to be irregular and inaccurate in his eating. This is normal. To feed himself as a doctor feeds a patient would be abnormal for the layman. Let him therefore sometimes have too much, sometimes too little, sometimes an improper balance; nature's resiliency stands ready to protect him. Nature has fitted him for guidance by casual estimates as to what, when, why, and how much. It is not good for the layman to become excessively preoccupied with the accuracies of his nutrition. That way lies hypochondria. The specialist's mode of thinking will not do for the layman. The two kinds of science are not interchangeable.

The specialist's science is held in high esteem, since it is seen to guide man's advance along a thousand lines. But the layman's science is neglected. It guides nobody's advance. It is held in contempt. High schools and junior colleges are completely directed toward the patrician matter of specialization;

they view layman's science as illegitimate and needless. And yet, it is in the layman's science that the solution to the basic problems of public health is to be found. For the layman's science is the key to the layman's right doing. It shows him his needs. It awakens his wants. It guides him on his way.

To enable the layman to do his part in promoting the public health, the basic task is to equip him with a live and functioning understanding of the layman's health science. If this science is genuine and active, it will show him his responsibilities and inspire him to discharge them. The power of understanding to stir men to action and to guide them in technical and professional performance is taken for granted. Laymen are the same persons with the same minds. Give them the layman's science in living and functioning form and it will guide them in the same effective way.

To equip the minds of all men and women with an active type of layman's science should be the basic and chief function of high schools and colleges of liberal arts. Since life is one hundred per cent doing, since science alone can properly guide the voluntary aspects of this doing, and since the purpose of education is to fit individuals for right-doing, it follows that the intellectual portion of education should be about one hundred per cent science. Prior to specialization, it should be layman's science. It is time, therefore, for the high schools and liberal arts colleges to discard their ancient and counterfeit programs, to lay aside their camouflaging robes and mediaeval ritual, and to buckle down to programs based on proved and definite needs. The ponderous modern world cannot be sustained on the flimsy ancient foundations.

The objective in making laymen competent in the health area is to enable them to understand and to live up to their understanding. It is a dual program of health science and the practical application of that science. It is an apprenticeship program in which physicians, nurses, teachers, parents, and young people participate.

Physicians stand *ex officio* as the visible and operating embodiment of health science. It is obviously their function to prepare from their specialist's science a simpler version for the layman, to keep it currently revised, and to see that it is kept in the hands of youth, parents, teachers, and nurses. Physicians can best judge how well it functions in families, in schools, and elsewhere as the standard guide to physical living and health care. As experts operating through the avenues of intelligence they have the power to keep the program vital and effective. In this way the experts can rule and the people can still be free.

The specialists in any area of human living are *ex officio* the leaders of the people's understanding and thought in that area. For that portion of human behavior they are the chief educators, the ultimate authority as to what education is to be. The medical profession, however, has been reluctant to accept this educational leadership. It would do well to make an exhaustive investigation of the question. For unless the medical profession finds the right road for a free profession in a free society, unless both the profession and the public are guided by a generally diffused intelligence, a regimented state medicine is probably inevitable. The world is not going to stumble upon the right road. Both self-interest and community interest demand that the medical profession examine carefully this problem of establishing a layman's health science.

Public health nurses in schools and in homes can represent the medical profession in dealing with routine and detailed matters. Their specialization places on them *ex officio* the responsibility for most of the systematic school and community teaching of applied health science. They are in a position to teach it as a normal and essential part of the apprenticeship process.

The foundations of applied health science are the pure sciences. The teachers in high schools and junior colleges should be concerned with presenting the whole array of pure sciences for the use of the layman.

The parents are the customers. They are buying both health and education in the health apprenticeship package. It is their responsibility to see that their physical living and that of their young people are carried on within normal limits. An apprenticeship program would lighten rather than increase the present-day burden of parents and it would also vastly improve performance. It would awaken parents both to the personal and to the broader social applications of the health program.

In this health apprenticeship the young and growing laymen are the center of the process. It will not hamper them too much to carry on their physical activities within normal limits. Their resiliency is great. They can exercise their exuberance with great freedom. But their understanding of health science should be increased as rapidly as is practicable; it should keep before them the limits of safety that are not to be passed.

Apprenticeship in the science of health is only one of the vital areas in the layman's all-around education. There are several dozen others which are equally essential. There is no possibility of adequately dealing with these areas one at a time. The only workable plan is to set up a comprehensive program of layman's education that takes care of all areas in an organic way. Let us commission our high schools and colleges of liberal arts, with their now wasted time, to do the job properly.

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